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SOURCE TEMPERATURE CONTROLLER PSDIG POWER SUPPLY MAINTENANCE MANUAL

J. C. SCHUMACHER COMPANY

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WARRANTY

J. C. Schumacher Company Power Supply units and Source Temperature Controllers are warranted against defects in materials and workmanship for a period of ninety days from date of shipment provided the equipment is used according to specifications and is not subjected to misuse or improper handling. Consult factory for authorization before returning equipment for maintenance.

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SECTION I—DESCRIPTION

1.1 GENERAL

This manual contains descriptive information, installation and operating instructions, a theory of operation, maintenance instructions and parts lists for J. C. Schumacher Company Source Temperature Controller PSDIG Series Power Supplies of which the PSDIG-14 and PSDIG-18 are the basic units. (The PSDIG-14 has been replaced with the PSDIG-18). The manual is divided into four sections, each dealing with one of the subjects listed above. Consult the Table of Contents for the location of the several sections and the paragraphs of which they consist.

A complete system consists of one of several available Source Temperature Controllers (STC'S) and one of the Power Supplies Listed in Table 1-1. However, reference to the STC within this manual is made only to the extent necessary to explain the functioning of the Power Supply.

1.2 PURPOSE OF EQUIPMENT

The J. C. Schumacher Company furnishes chemicals to the semiconductor and fiberoptics industries. Since application by the user requires precise temperature control of these chemicals, the company also supplies Source Temperature Controllers (STC'S) in several sizes that accommodate the quartz bubblers in which the chemicals are shipped. The Power Supplies provide the electrical power and necessary current control to maintain a selected temperature and, therefore, constant vapor pressure within the bubbler.

1.3 FUNCTIONAL DESCRIPTION

A complete system consists of a Source Temperature Controller, in which the

Table 1-1. PSDIG Series Power Supply Model Numbers and Distinguishing Features.

MODEL NUMBER	FEATURES
PSDIG-14	Basic, 3-Mode (Operates with 500 cc and 1500 cc STC's (-5°C to +45°C).*
PSDIG-15	PSDIG-14 with Temperature Error Alarm.*
PSDIG-16	PSDIG-14 with Remote Control Panel.*
PSDIG-17	PSDIG-18 with Extended Low Temperature Range (-25°C to +30°C).
PSDIG-18	PSDIG-14 with Revised Power Supply Circuit.
PSDIG-20	PSDIG-14 with Voltage Output Amplifier.*
PSDIG-21	PSDIG-18 with Extended High Temperature Range (+40°C to +100°C).
PSDIG-22	PSDIG-18 for 10 Liter STC.
PSDIG-23	PSDIG-18 with Voltage Output Amplifier for DDC.
PSDIG-24	PSDIG-18 with Remote Control Panel.
PSDIG-25	PSDIG-18 with Temperature Error Alarm.
PSDIG-26	PSDIG-18 with Factory Wired 230V.
PSDIG-27	PSDIG-18 with DDC, Remote Control Panel.
PSDIG-28	PSDIG-18 with 100V (Japan).
PSDIG-29	PSDIG-18 with 100V, DDC (Japan).
PSDIG-30	PSDIG-18 with 230 Volt, Remote Control Panel, Temperaure Error Alarm.
PSDIG-31	PSDIG-18 with Extended Low Temperature (-25°C to +30°C), Remote Control Panel.

*Model PSDIG-14 replaced by PSDIG-18.

bubbler containing the chemical is placed, and the Power Supply. Standard Range and Low Range STC's are equipped with thermoelectric coolers. They are also equipped with heaters and temperature sensing probes. The heater offsets the effect of the thermoelectric cooler to attain the desired operating temperature within the specified range. The High Range STC's (those that operate above room temperature) are similar, but are not equipped with the thermoelectric cooler. A multiple conductor cable connects the STC to the Power Supply, providing current paths for the thermoelectric cooler, heater and temperature probe.

CAUTION

The cable used to interconnect the STC and the Model 14 or 18 Power Supply described in this manual should be J. C. Schumacher Co. Part No. 2101-0001. This cable will be marked "3 MODE ONLY". Use of a cable with a different part number and not MARKED "3 MODE ONLY" will create a ground condition that is hazardous to personnel.

The PSDIG-14 operates from commercial power of 115 volts AC at 50 to 60 Hz. The -18 operates from either 100, 115 or 230 volts AC at 50 to 60 Hz. The voltage range for the -18 is determined by connection of taps on the line power transformer as described in Section II. Variants of these Power Supplies will operate from the same power sources. (See Table 1-1). The Power Supplies furnish a regulated voltage for the STC thermoelectric cooler and voltage pulses at varying rates to the heater. Thus, an average power level is established in the heater that will maintain the temperature of the chemicals in the bubbler within $\pm 0.3^{\circ}C$ of the selected temperature.

The Power Supply senses a voltage drop across the probe which is proportional to temperature and compares it with a voltage determined by the the set point adjustment. Circuits within the Power Supply then adjust the pulse rate in the heater circuit so that the differential between the set point and probe voltages is essentially zero which indicates that the temperature in the STC is that selected with the set point adjustment.

1.4 PHYSICAL DESCRIPTION

A PSDIG-18 Power Supply and one of the STC's are shown in Figure 1-1. The Power Supplies are housed in attractive, all metal cases measuring 8-1/2 inches wide, 5-3/4 inches high (including supporting feet) and 10-7/8 inches deep (including rear panel transistor heat sinks and electrical connectors). Front panel controls consist of illuminated, push-on/push-off POWER and COOL switches and a CAL-SETPOINT switch. The CAL-SETPOINT switch selects calibration voltage, temperature and set point voltages for display on a three and one-half digit, LED read-out device. A green LED on the front panel is illuminated when the voltage pulses are applied to the STC heater. The case is modular in design providing ease of disassembly for access to the internal circuit boards and DC power supply components.

The STC is housed in a cylindrical metal case and is equipped with an electrical receptacle for the interconnecting cable connector and with a fan to force air over the thermoelectric heatsink.

1.5 OPTIONAL FUNCTIONS

There are several optional functions and physical arrangements for the Power Supplies. Inclusion of one or more of these results in a different model number as listed in Table 1-1. The Temperature Error Alarm Option causes the front panel display to flash and provides an SPDT relay contact closure at the rear panel connector when the difference between set point and actual temperature exceeds preset limits. The Voltage Output Amplifier provides an analog output through which one of the several test points within the heater regulator circuit may be monitored. The output of

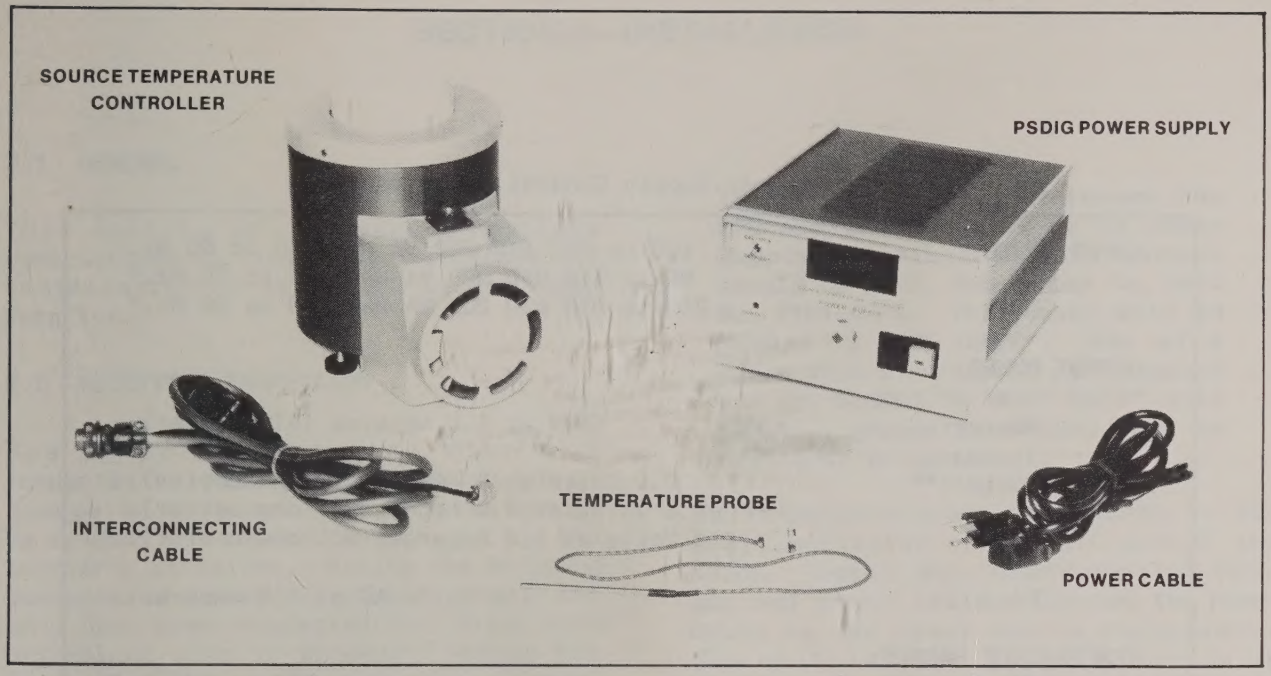


Figure 1-1. Source Temperature Controller System Components.

this amplifier may be connected to a chart recorder, DDC computer or other display device.

In addition, Remote Set Point, Remote Control Panel, Front Panel Set Point, BCD Voltage Output and Extended Low Temperature and High Temperature Range options are available.

1.6 SPECIFICATIONS

Specifications for the PSDIG Series Power Supplies are listed in Table 1-2.

Table 1-2. Power Supply General Specifications

INPUT POWER:	105 to 125 VAC 200 VA Max, 50 to 60 Hz. 90 to 110 VAC 200 VA Max, 50 to 60 Hz.* 210 to 250 VAC 200 VA Max, 50 to 60 Hz.*
OUTPUT POWER:	
Heater:	110V at 1.0 Amperes (STC Heater).
Cooler:**	6.0 Volts at 3 Amperes (2 ohm cooler). 4.8 Volts at 4.8 Amperes (1 ohm cooler). 2.4 Volts at 4.8 Amperes (0.5 ohm cooler).
Fan:	110 Volts AC at 1.0 Amperes.
TEMPERATURE RANGES:	
Standard:	$-5^{o}C$ to $+45^{o}C$.
High Temperature:	$40^{o}C$ to $+100^{o}C$.
Low Temperature:	$-25^{o}C$ to $+30^{o}C$.
ACCURACY:	$\pm 0.3^{o}C$ overall. $\pm 0.1^{o}C$ resolution and stability.
ENVIRONMENTAL:	
Temperature:	$0^{o}C$ to $50^{o}C$.***
Humidity:	0 to 90%.
MECHANICAL:	
Dimensions:**	5.25 in. High, 8.56 in. Wide, 10.88 in. Deep. (13.4 mm High, 21.8 mm Wide, 27.5 mm Deep).
Weight:	12 Pounds (5.5 Kg).

*Model PSDIG-18 Series.
**Type of STC automatically sensed.
***STC may not provide cooling to lower limit at ambient temperatures above $40^{o}C$.
****Not including remote panels.

SECTION II—INSTALLATION

2.1 GENERAL

This section of the manual provides instructions for inspection, checkout and installation of the PSDIG Series Power Supplies.

2.2 RECEIVING INSPECTION

The shipping container should be inspected on receipt for indication of damage in shipment. If external damage is evident, it should be brought to the carrier's attention. Retain the shipping container and internal packing until the unit has been inspected and it has been determined that in-shipment damage has not occurred. Inspect the external surfaces for scratches, dents or other evidence of in-shipment damage. As stated in the warranty printed in this document, equipment should not be returned to J. C. Schumacher Co. without prior authorization. Consult the warranty statement for details.

If no damage is evident, interconnect the Power Supply and Source Temperature Controller as directed in Section 2.3. Read the instructions of Section III, then proceed with the installation and checkout as directed in the following paragraphs.

2.3 INSTALLATION

The STC and the Power Supply are designed to be placed on a flat, stable surface. The STC is equipped with three adjustable supports for leveling. Two cables are furnished with the system. One connects the STC to the Power Supply. The other connects the Power Supply to commercial AC power. (See paragraph 2.4). The manner in which the cable is installed is readily apparent since the connectors are of different sizes and types.

CAUTION

The cable used to interconnect the STC and the Model 14 or 18 Power Supply described in this manual should be J. C. Schumacher Co. Part No. 2101-0001. This cable will be marked "3 MODE ONLY". Use of a cable with a different part number and not MARKED "3 MODE ONLY" will create a ground condition that is hazardous to personnel.

The temperature probe is attached to the small connector on the STC end of the cable. Install the interconnecting cable and the power cable. Connect the power cable to the power source receptacle. The unit is then ready to operate as described in Section III.

CAUTION

When placing the STC in source cabinet, be sure that the fan intake is facing away from the furnace tube.

2.4 TRANSFORMER TAP CONNECTIONS

Variants of the PSDIG-18 may operate from three different line voltages depending on the connections to the power transformer primary taps. The voltage for which the unit is factory wired is indicated on the rear panel label.

CAUTION

Care must be exercised that the Power Supply is not connected to a source of power other than that indicated on the rear panel label. If transformer taps are reconnected for another voltage, mark the rear panel conspicuously to indicate the proper voltage to be applied.

Figure 2-1 illustrates the connections to the power transformer for various supply voltages.

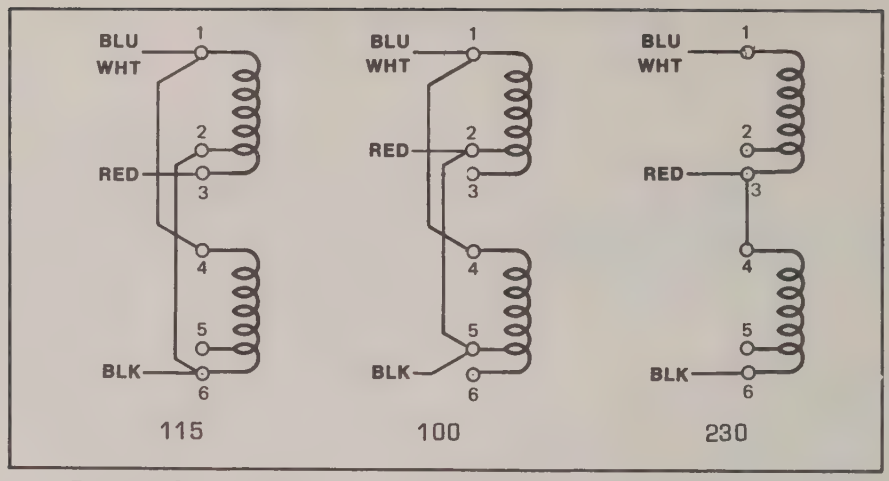


Figure 2-1. PSDIG-18 Power Transformer Connections.

2.5 PRE-OPERATIONAL CHECKOUT

The PSDIG Series Power Supplies and Source Temperature Controllers are thoroughly tested at the factory before shipment and are carefully packaged to avoid damage in shipment. Damage in shipment is rare, especially if the packing carton shows no evidence of damage. Therefore, the Power Supply and STC should be ready for operation on receipt. However, it may be desirable to conduct the pre-operational checkout of this section as verification of satisfactory operation and to obtain familiarity with operational procedures before placing the system in daily operation. The pre-operational checkout procedure follows:

1. Place a calibration bubbler into the Source Temperature Controller (STC) and fill it approximately two-thirds full of water and some type of anti-freeze liquid. The thermowell should be filled with refined castor oil, either Crystal-O or DB-Oil. Cover the bubbler with one of the foam pads that was supplied with the system.

CAUTION

Use only the liquids recommended above in the thermowell. Do not use water or a volatile solvent such as acetone, alcohol, etc. Irreparable damage to the temperature probe will result from use of such liquids.

NOTE

A foam pad should **not** be installed **between** the bubbler and the STC cup.

2. Adjust the temperature set point, as directed in Section III, for the low temperature limit and insert the probe in the thermowell. Allow the temperature to stabilize. The time required for temperature stabilization will vary with the size of the STC and the temperature range of the unit from a minimum of one hour to a maximum of four hours.

3. Immerse a calibrated thermometer in the liquid and verify that the temperature is within $\pm 0.3^{\circ}C$ of the set point temperature.

4. Readjust the set point for the high temperature limit and allow time for for temperature stabilization.

5. Immerse the thermometer in the liquid and verify that the measured temperature is within $\pm 0.3^{\circ}C$ of the set point temperature.

SECTION III—OPERATION

3.1 GENERAL

This section of the manual provides instructions on operation of the Source Temperature Controller and PSDIG Series Power Supplies.

3.2 POWER UP

Press the red POWER push button which will then illuminate to indicate that power has been applied. If the COOL push button is also illuminated, push it in and then release it. Its lamp should then be extinguised. When power has been applied, the probe temperature will be displayed on the three and one-half digit readout. At room temperature, this will be approximately +25°C.

3.3 CALIBRATION CHECK

Calibration of the unit is verified by pushing the CAL - SETPOINT switch up to the CAL position. The display reading should correspond to that of Table 3-1. The instrument should be recalibrated in accordance with the procedures of Section V if the calibration display reading varies more than ±0.4 digits from the stated value.

3.4 SET POINT ADJUSTMENT

The set point, which is the temperature at which the chemical in the bubbler will be maintained, is read on the display by pushing the panel switch down to the SET POINT position. On those models with front panel set point adjustment, turn the control clockwise to increase the set point and counterclockwise to decrease it. On those models that do not have front panel or remote set point adjustment, the set point may be adjusted over the range as follows:

1. Peer through the small hole in the top panel of the Power Supply and note the screw which is visible. Insert a small **insulated** screwdriver through the hole and engage the screw. The set point temperature is increased by turning the screw clockwise and decreased by turning it counterclockwise.

Table 3-1. Calibration Display Values.

MODEL NUMBER	CALIBRATION DISPLAY VALUE
PSDIG-14	175.9
PSDIG-15	175.9
PSDIG-16	175.9
PSDIG-17	147.1
PSDIG-18	175.9
PSDIG-20	175.9
PSDIG-21	187.0
PSDIG-22	175.9
PSDIG-23	175.9
PSDIG-24	175.9
PSDIG-25	175.9
PSDIG-26	175.9
PSDIG-27	175.9
PSDIG-28	175.9
PSDIG-29	175.9
PSDIG-30	175.9
PSDIG-31	147.1

CAUTION

Care must be exercised that the screwdriver is engaged in the screw slot before turning. Otherwise, components on the regulator circuit board may be damaged.

2. When the desired temperature set point is displayed, remove the screwdriver and release the switch.

NOTE

The set point adjustment has a range that exceeds the temperature regulation limits of the instrument. Do not adjust the set point such that the displayed set point temperature is outside the range of the Power Supply. Refer to Table 1-1 for the temperature limits of the Power Supply to which

adjustment is to be made. A screwdriver adjustment will continue to turn when it has reached its extreme travel although there will be no further change in the displayed set point temperature.

3.5 SETTING UP

Setting up the equipment for operation consists of inserting the bubbler in the STC, connecting the bubbler input and output tubes to the gas jungle and immersing the temperature probe in the thermowell of the bubbler. The connection of the bubbler to the jungle is beyond the scope of this manual. A foam pad is furnished with the STC which is intended as a cover for the bubbler to insulate it from the ambient temperature.

NOTE

A foam pad should **not** be installed **between** the bubbler and the STC cup.

The thermowell should be filled with refined castor oil, either Crystal-O or DB-Oil.

CAUTION

Use only the liquids recommended above in the thermowell. Do not use water or a volatile solvent such as acetone, alcohol, etc. Irreparable damage to the temperature probe will result from use of such liquids.

3.6 TEMPERATURE REGULATION

The Power Supply will not regulate the temperature of the STC unless the COOL push button has been depressed and its lamps are illuminated. The standard and low temperature systems always offset the temperature of the thermoelectric cooler by passing current to the heater if the set point is above the thermoelectric cooler temperature. When the COOL button is depressed, the fan in the STC will start and current will be applied to the thermoelectric cooler. If the set point is set near one of the extreme temperature limits, as much as four hours may be required for temperature stabilization. The progress of temperature stabilization can be monitored by observing the front panel display with the switch at its center position.

The CONTROL indicator is illuminated whenever current is supplied to the STC heater. Therefore, if the set point is lower than room temperature, the CONTROL indicator on the Power Supply front panel will not be illuminated until the thermoelectric cooler has lowered the temperature to the set point. When the temperature has been stabilized, it will be held within $\pm 0.3^{\circ}C$ of the set point as long as the temperature probe is immersed in the thermowell to a depth of three inches and the thermowell is filled with the type of fluid recommended in Section 3.5.

3.7 TERMINATING OPERATION

There are no special procedures for terminating operation of the system. It may be advisable to release the COOL push button (push-in and release) before power is removed from the Power Supply. This assures that the thermoelectric cooler and heater are disconnected and will not be connected when the unit is next turned on until the operator is ready. Pushing and releasing the POWER push button removes power from the system.

SECTION IV—THEORY OF OPERATION

4.1 GENERAL

This section of the manual contains both functional and detailed circuit descriptions of the PSDIG series Source Temperature Controller Power Supplies. The functional descriptions are referenced to a block diagram and the detailed descriptions are referenced to the schematic diagrams of Section VII.

The several models of the PSDIG Series Power Supplies are variants of the Model PSDIG-14 (obsolete) or PSDIG-18. All use the same temperature controller circuit and the only difference between the -14 and -18 are the DC power supply circuits. The differences between the other models and the -14 and -18 are mostly mechanical with the exception of the resistor substitutions required for the extended temperature range models. (See parts lists of Section 6.) Therefore, the material in this section will apply to all models, since both power supply circuits are detailed as are the circuits of the electronic options.

4.2 FUNCTIONAL DESCRIPTION

Refer to Figure 4-1, which is a block diagram of the circuits of the PSDIG-14 and PSDIG-18. A temperature probe senses the absolute temperature of the liquid in the bubbler contained in the STC. It is connected through a cable to the input of the Controller Power Supply. The reference DC supply provides a regulated, fixed voltage to the voltage divider of which the temperature probe is a part. The voltage at the junction is applied to the input amplifier which has unity gain and presents a high impedance to the probe circuit. The input amplifier has two stages with the second being equipped with an offset adjustment. Its output is proportional to temperature on a scale of ten millivolts/^{o}C.

The differential amplifier is also a two-stage system with gain and balance adjustments. It senses the difference between the voltage at the output of the input amplifier and that at the arm of

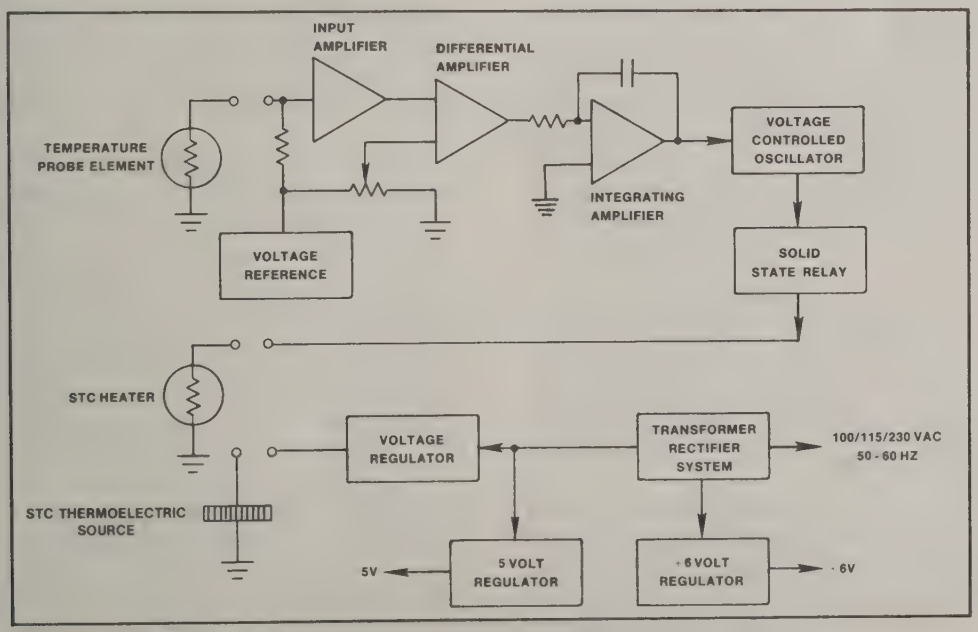


Figure 4-1. Block Diagram, PSDIG Power Supply.

the set point potentiometer. The output of the differential amplifier is proportional to the difference between its two inputs.

For a given set point temperature, a fixed current to the heater will, theoretically, provide for the losses due to convection and radiation while maintaining a constant liquid temperature. However, the losses are not constant and the current to the heater must be increased or decreased from time to time. There is appreciable thermal delay between the heater and the temperature probe, due to the mass of the STC and its liquid. If the heater were merely turned on and off as the probe sensed temperature changes, the temperature would oscillate over wide limits and drift with disturbances. The action of the integrating amplifier helps maintain the temperature within practical limits as explained in the following paragraph.

The gain of the integrating amplifier is large since there is no DC feedback path. However, large capacitors in the input and feedback paths provide a time constant of between 20 and 28 minutes. Therefore, when a difference between the actual temperature and the set point temperature occurs, it will not produce an immediate large change at the output of the integrating amplifier. Rather, the output will gradually change with time if the temperature difference remains or increases. The integrating amplifier provides the control voltage to the voltage controlled oscillator (VCO).

The VCO produces pulses of uniform width, but with rates dependent on the control voltage level. The pulses from the VCO trigger a solid state relay at zero crossings of the line AC to modulate the current to the heater.

If a temperature difference exists for a period of time, the number of pulses will be gradually increased or decreased to start the temperature back to the set point. The initial change will be small and will increase until the probe senses the temperature returning to the set point. Then reverse action will start to reverse the pulse rate trend. The result is an asymptotic approach of heater power to the value that will maintain the temperature in the STC at the selected value. In normal practice, temperature excursions are less than $0.1^{o}C$ and the temperature, for all practical purposes, may be considered constant.

Current for the thermoelectric cooler of the STC is also provided by the power supply which is designed to operate with any of the several models of the STC's. Internal adjustments individually set the proper voltage and current limits.

4.3 DETAILED CIRCUIT DESCRIPTION

The paragraphs of this section provide a detailed description of the PSDIG Series Source Temperature Controllers. Unless otherwise noted, the circuit component designators are those of the schematic diagram of Figure 7-9. Where more than one device is contained within an integrated circuit package, the device is identified by the circuit designator followed by a dash and the output pin number. For example, U2-7 identifies the operational amplifier of device U2 that has its output connected to pin 7.

4.3.1 REFERENCE VOLTAGE SOURCES

A type AD580J regulator provides a stable +2.5 volt reference, monitored at TP5, across the voltage divider comprised of R1, R8 and R9. R1 provides an adjustment of the voltage level at the non-inverting input of operational amplifier U2-14 and, therefore, at the output of U2-14. The output of U2-14 is an accurate and stable voltage level which provides, through R27, the current to the temperature probe elements connected to P1, P2 and P3. This voltage is monitored by the front panel meter when the switch is in the CAL position and also at TP1.

The +2.5 volt reference of U1 is inverted in operational amplifier U2-7 to -2.5

volts which is monitored at TP-6. The +2.5 volt and -2.5 volt sources are connected across the voltage dividers for the TEMP SET and BALANCE adjustments and for the offset adjustment of U3-14. Thus, the center points of the adjustment potentiometers are at ground potential, permitting + or - levels to be applied to the inputs of the operational amplifiers to which they are connected.

4.3.2 INPUT AMPLIFIER

The thermistor in the temperature probe of the associated Source Temperature Controller (STC) is a three-terminal device with two temperature sensitive elements. One element has a resistance of approximately 6K ohms at 25°C and is connected between P1 and P2. The resistance of the other, which is connected between P1 and P3, is approximately 30K ohms at 25°C. R26, connected in series with one temperature element provides linearization of the temperature probe characteristics over the temperature range.

The non-inverting input of operational amplifier U2-8 is connected to the junction of the voltage divider comprised of the elements of the temperature probe and R27. U2-8 is connected as a voltage follower and provides a high impedance to the temperature probe circuit and a low impedance at its output.

U2-8 is followed by operational amplifier U2-1 which operates at unity gain. The non-inverting input of U2-1 is connected to the arm of R2 which provides the offset adjustment for U2-1. The output of U2-1 is adjusted to produce a 0 volt output at 0°C. The scale factor at its output is 10 millivolts/°C which can be monitored during calibration at TP2.

4.3.3 SET POINT AMPLIFIER

The point at which temperature in the STC is to be maintained is referred to as the SET POINT and is determined by the adjustment of R5 in the local mode. In the remote mode, R5 is turned to its low voltage limit. A remote control voltage is then applied to TP8. CR8 isolates R5 from affecting the circuit when the external voltage is applied. Note that R5 is connected across the same voltage source as R1. Therefore, minor changes in the reference level will not appreciably affect calibration of the unit.

The arm of R5 is connected to the inverting input of operational amplifier U3-1 through R32 which, with R30, sets the gain of U3-1 at unity. U3-1, therefore, functions as an inverter. The correct operation of U3-1 may be monitored at TP7.

4.3.4 DIFFERENTIAL AMPLIFIER

The level at the output of U2-1 is positive-going with an increase in temperature at the STC. This is summed with the negative level from set point amplifier U3-1 at the junction of R24 and R28 which is connected to the inverting input of operational amplifier U3-8. The stage gain of the circuit of U3-8 is approximately 30. Its output will be proportional to the difference between the set point and temperature levels. The gain that is realized through the next stage, U3-7, will be determined by the setting of the GAIN adjustment, R7, since it determines the current in the feedback path. Stage gain is variable with R7 over a range of approximately 1 to 10. The BAL (balance) control, R6, is an offset adjustment for the overall amplifier consisting of U3-1, U3-8 and U3-7.

4.3.5 INTEGRATING AMPLFIER

The gain of the integrating amplifier is quite large, being the open loop gain of U6-6. However, the resistive/capacitive networks in the input and feedback circuits provide an integration time constant of between 20 and 28 minutes. This compensates for the mass of the STC by making the change in heater current quite small, initially, in response to a difference in actual and set point

temperatures as sensed by the differential amplifier.

If the temperature difference continues or increases, the incremental current change is gradually increased until the temperature starts back toward the selected value. As the temperature difference decreases, the output of U6-6 begins to slew in the opposite direction, reducing the incremental heater current change. The overall effect is an asymptotic approach of the heater current to the value that will maintain temperature. Note that the output of U6-6 follows the temperature differential, rising when the temperature falls and falling when the temperature rises.

4.3.6 HEATER CURRENT MODULATOR

U5 is a voltage controlled oscillator that outputs pulses of constant width, but with pulse frequency proportional to the voltage at its pin 7 which is connected to the output of U6-6 through R63. As the temperature drops from the set point value, the output of U6-6 decreases. This increases the number of pulses developed by U5 per unit time. Conversely, as the temperature rises above the set point, the number of pulses developed by U5 will be decreased. Each pulse has a width of approximately 8 milliseconds and the pulse rate varies between zero and 60 per second over the operating range. For each pulse, the normally open contacts of solid state relay U9 are closed for one-half of the line AC cycle starting at the next zero crossing following the leading edge of the actuating pulse. These pulses are applied to the STC heater. Therefore, as the temperature rises above the set point, the average power to the heater is decreased and is increased as the temperature drops. A green LED mounted on the front panel flashes with each pulse to provide a visual indication of control operation. Flash rate, however, may be more rapid than the eye can follow and it may appear to glow steadily.

4.3.7 METERING

The three and one-half digit display on the front panel is selectively connected through the meter switch to TP1, TP2 and TP8. At the TP1 connection, it reads the calibration voltage times 100. At the TP2 connection, it reads the STC probe temperature in degrees Celcius. At the TP8 position, it reads the selected temperature set point.

4.3.8 AUXILIARY AMPLIFIERS

An auxiliary operational amplifier, U3-14, is provided as standard. By connecting TP4 to another test point on the board, the level at that test point may be externally monitored. R4 provides an offset adjustment and R3 provides a gain adjustment for U3-14. The output of U3-14 is connected to TP3. Note that this amplifier has an inverted output.

A second auxilliary amplifier (optional) is provided by U4-14 and U4-8. It provides differential operation and adjustable offset control. It is typically used for remote input or as an output amplifier for a DDC Computer.

4.3.9 POWER SUPPLY

There are two versions of the power supply in the field. The schematic circuit diagram for the early version, which is installed in the PSDIG-14 and all variants thereof, is shown in Figure 7-5. The later version, which is installed in all models based on the PSDIG-18 is shown in Figure 7-7. The component designators referenced below are those of Figure 7-5 which are readily cross referenced to those of Figure 7-7. The +5 volt and -5 volt supplies of both units use an identical circuit. However, the PSDIG-18 uses a +6 volt regulator. The transformer secondary voltage is rectified by diodes CR2 and CR4 to produce approximately +12 volts DC at the input of +5 volt regulator U2 and by CR1 and CR3 to produce approximately -12 volts DC at the input of -5 volt regulator U4. The regulators are

protected against application of reverse voltages by diodes CR5 through CR8. The 4.7 microfarad tantalum capacitors provide bypassing at the inputs and outputs of the regulators.

The principle difference between the -14 and -18 power supplies is in the regulator for the STC thermoelectric cooler. The -12 volt bus supplies the current through Q1 and Q2 which are connected in parallel. The regulator circuit provides voltage regulation and current limiting.

Refer to Figure 7-5 which is the schematic diagram of the -14 power supply circuit board. Voltage regulator U1 is of a type where the output voltage is determined by the ratio of two resistors in a voltage divider circuit. Note that current flows from ground through R8 and R5, into the OUT terminal of U1, through U1 to its IN terminal and then through the base-emitter junctions of Q1 and Q2 to the -12 volt bus. The COM terminal of U1 is the reference input from the junction of R5 and R8.

Regulator U1 will maintain its COM terminal at a potential 1.25 volts more negative than its OUT terminal. Note that, neglecting R7, these two terminals are connected to the ends of R5. The current that flows into the COM terminal is negligible. Therefore, the current through R8 will be the same as the current through R5 and the voltage at the circuit output terminals will be that current (10 milliamperes) times the total resistance of R5 and R8. This can be adjusted with R8 to the specified limit level.

The current through the base-emitter junctions of Q1 and Q2 will turn them on. However, the current they furnish under a no-load condition is part of the ten milliamperes that flows through R5 and R8, the balance coming from U1. R5 and R8 are connected across the load terminals. If a load is connected across the circuit output, the output voltage will tend to drop. To maintain the 1.25 volt differential between its COM and OUT terminals, U1 will draw more current through the base-emitter junctions of Q1 and Q2, causing more collector current to flow, furnishing the required current to the load.

Current limiting is provided by the circuit of operational amplifier U3-6. The gain of the amplifier circuit is determined by the ratio of R4 and R6 with R4 providing an adjustment and, therefore, the point at which current limiting will occur. When the current through the load reaches the current limit point, the voltage across R90 will cause the output of U3-6 to slew in a positive direction, forward biasing diode CR9. This causes current to flow in R7 producing a voltage drop. The drop across R7 is then in series with that across R5 and will tend to increase the differential between the COM and OUT terminals of U1. To counteract this increase and maintain a 1.25 volt differential, U1 will decrease the current flowing between its IN and OUT terminals. This decreases the base current through Q1 and Q2 which will reduce the collector current. There is a closed loop around the circuit, therefore, it stabilizes at the current limit set point.

Refer to Figure 7-7 which is the schematic diagram of the power regulator circuits of -18 units. The circuit of operational amplifier U1-1 provides voltage regulation and that of U1-8 provides current limiting.

The voltage at the non-inverting input of U1-1 is set at -3 volts by the voltage divider comprised of R4 and R5. A second voltage divider, comprised of R8 and R9, has its junction connected to the inverting input of U1-1. Feedback for this circuit is through transistor Q1 (on the board) and Q1 (on the chassis). Any differential at the inputs to U1-1 will cause its output to drive the bases of Q1 and Q2, through Q1 (on the board) in the direction that will restore its non-inverting input to -3 volts. Since

the gain of the circuit of U1-1 is quite high, the voltage across the load is maintained within close limits.

The voltage at the inverting input of U1-8 is set with R12. This establishes the current limit point. Resistor R10 is in series with the load resistance and the voltage drop across it is applied to the non-inverting input of U1-8. As long as the load current is within prescribed limits, the voltage at the non-inverting input of U1-8 is more positive than its inverting input and the output is slewed in a positive direction. If the load current exceeds the set limit, the voltage drop across R10 will exceed that at the inverting input of U1-8, causing its output to slew to a point more negative than the junction of R8 and R9. This will forward bias CR9, causing the inverting input of U1-1 to be pulled more negative. The output of U1-1 goes more positive, reducing the base drive to Q1 and Q2 and limiting the current to the load. Since there is a closed loop between the collectors of Q1 and Q2 and the input of U1-8, the circuit stabilizes itself at the current limit set point.

SECTION V—MAINTENANCE

5.1 GENERAL

This section of the manual contains maintenance instructions for the PSDIG Series Power Supplies in the form of calibration procedures, troubleshooting guides and disassembly procedures. Section IV -- Theory of Operation has been included in this manual as a service aid. The servicing technician should be familiar with the material of Section IV before attempting to troubleshoot the unit.

CAUTION

Hazardous voltage potentials are present at the terminals of components mounted on the front and rear panels and at the forward terminals of the power transformer. Personnel should use extreme caution not to come in contact with these potentials when servicing the unit. Remove power by disconnecting the power cord at the rear panel except when taking measurements.

5.2 CALIBRATION

The PSDIG Series Power Supplies will retain their calibration over long periods. The calibration procedure need only be performed when the display of set point and probe temperatures, after stabilization, vary by more than 0.2°C or when the unit has been repaired and components replaced. The calibration procedure requires a digital multimeter with accuracy better than 0.05%. The procedure follows:

1.The calibration procedure requires a dummy probe. Such a probe can be constructed with a Gorn Electronics GH-7F, or equivalent, connector and two resistors. The resistors must be 5.7K ohms and 35.2K ohms, have tolerances of 0.1% and temperature coefficients of 25 ppm/°C. The 5.7K ohm resistor is connected between pins D and F of the connector and the 35.2K ohm resistor is connected between pins E and F.

2. Remove the top cover of the Power Supply per paragraph 5.4.1.

3. Remove power from the Power Supply and connect the dummy temperature probe by separating the small connector on the STC cable and plugging the GH-7F connector into the mating portion.

4. Connect the DVM lead to 'LO' on the controller circuit board. Turn on the Power Supply and verify the voltages on the controller circuit board by connecting the positive lead of the DVM to the test points shown in Table 5-1.

Table 5-1. Power Supply Voltages.

TEST POINT	VOLTAGE
+5V	+5.0 ±0.3 volts DC*
+5V	+6.0 ±0.3 volts DC**
NEG	-5.0 ±0.3 volts DC
GRND	0.0 ±0.001 volts DC
TP5	+2.50 ±0.15 volts DC
TP6	-2.50 ±0.15 volts DC

*PSDIG-14 Power Supplies and Variants.
**PSDIG-18 Power Supplies and Variants.

5. Connect the positive lead of the DVM to TP1 on the controller circuit board and adjust R1 for a reading in accordance with Table 3-1 ±0.0005 volts DC.

6. Connect the positive lead of the DVM to TP2 on the controller circuit board and adjust R2 for a DVM reading of 0.232 ±0.0005 volts DC.

7. Connect the positive lead of the DVM to TP8 on the controller circuit board and adjust R5 for a DVM reading of 0.232 ±0.0005 volts DC.

8. Connect the positive lead of the DVM to TP7. Verify that the DVM reading is -0.232 ±0.010 volts DC.

9. Adjust R7 to its clockwise limit, then back off three full turns.

10. Connect the positive lead of the DVM to TP9. Adjust R6 for a DVM reading of 0 ±0.010 volts DC.

11. Connect the positive lead of the DVM to 'HI'. Verify that the DVM reading is 0.232 ±0.001 volts DC and that the front panel display reads +23.2.

12. Depress the front panel switch on the Power Supply. Verify that the DVM reading is 0.232 ±0.001 volts DC and that the front panel display reads +23.2.

13. Raise the front panel switch on the Power Supply. Verify that the readings of the DVM and the front panel display are in accordance with Table 3-1.

14. Turn R5 two turns clockwise and verify that the green LED on the Power Supply is turned full on.

15. Turn R5 four turns counterclockwise and verify that the green LED is turned off.

16. Remove power from the Power Supply.

17. Disconnect the STC from the Power Supply. Connect a 2 ohm, 50 watt resistor between TP12 and TP6 (TP10 on -18) on the DC power supply board.

NOTE

The values provided are for adjusting the Power Supply for use with an STC requiring 6 volts, i.e., 1500 cc STC's and 500 cc STC's with model numbers higher than 7. Use a 1 ohm resistor for 6.0 volts and a 0.5 ohm resistor for 2.5 volts.

18. With a 2 ohm load, set current potentiometer (R4 on -14, R12 on -18) at maximum limit. On -14 only, set voltage potentiometer R8 for 6.0 volts DC across the 2 ohm load. Then set the current potentiometer for minimum.

19. Replace 2 ohm load with 1 ohm load and adjust current potentiometer for 5.0 volts across load.

20. Replace the 1 ohm load with a 1/2 ohms load and verify that the voltage across the load is 2.5 ±0.25 volts.

21. Proceed with pre-operational check out in 2.5.

5.3 TROUBLESHOOTING

The troubleshooting guide of Table 5-2 lists several trouble symptoms and their possible causes. Familiarity with the contents of Section IV of this manual will materially aid the technician with troubleshooting the unit if the problem is not revealed by the contents of Table 5-2.

5.4 DISASSEMBLY

It will be necessary to at least partially disassemble the Power Supply to gain access to the rear side of the circuit boards and for removal and replacement of some components. Disassembly should adhere to the instructions of this section, where provided, to avoid damage to electrical components that may require disconnection before circuit boards and panels can be removed. Photographs illustrate certain parts of the disassembly procedure. Unless otherwise noted, reassembly is the reverse procedure from disassembly. Disassembly procedures are omitted where they are clearly obvious.

5.4.1 TOP AND BOTTOM COVER REMOVAL

The top and bottom covers must be removed as a first step in any disassembly procedure. The covers are assembled to the case by sliding them into grooves in each side panel. They are secured by two screws that thread into the back panel. To remove these covers, remove the screws and slide the covers rearward clear of the case. See Figure 5-1.

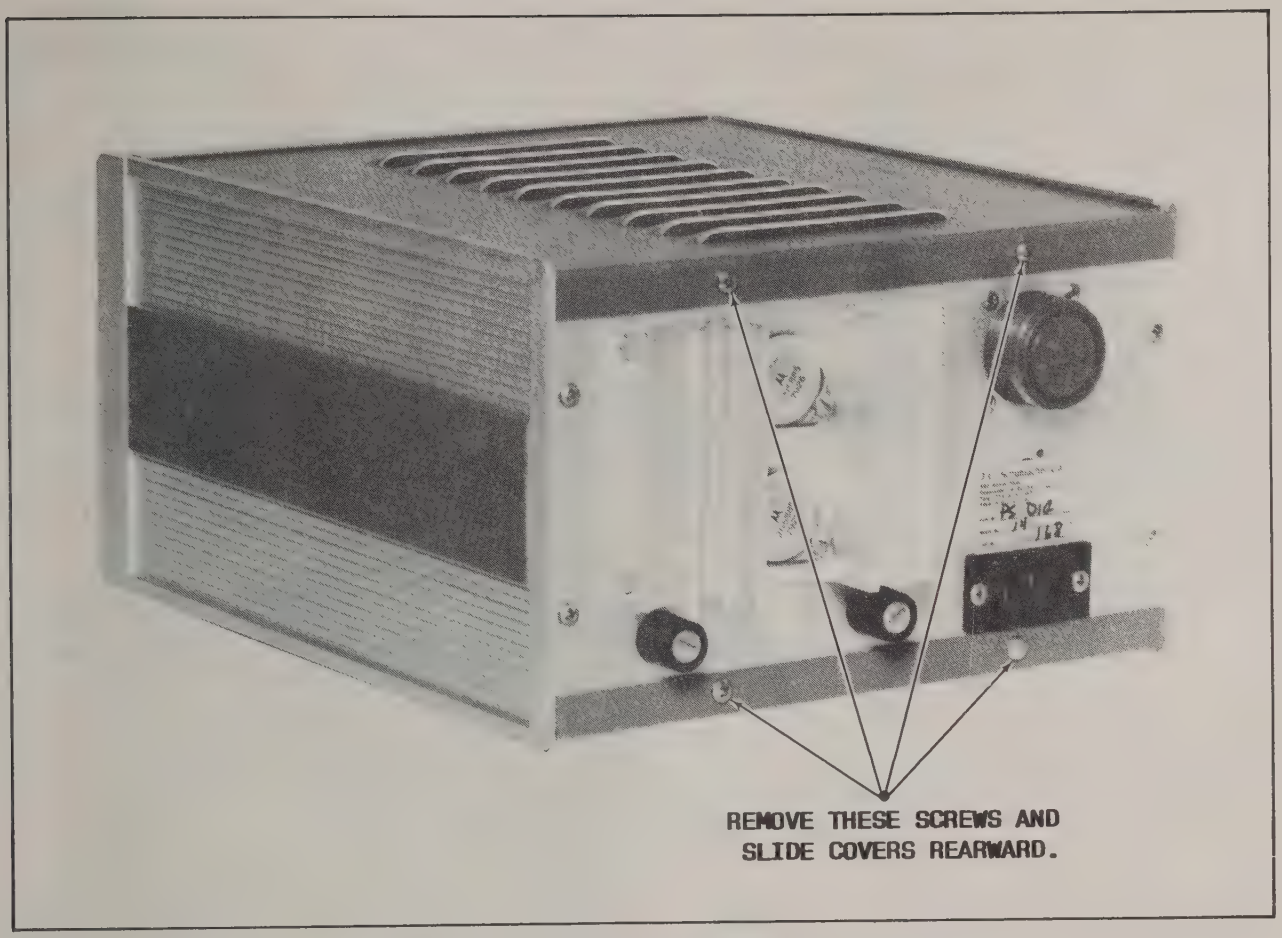


Figure 5-1. Rear View of Power Supply Showing Cover Retaining Screws and Cover Removal.

5.4.2 FRONT PANEL REMOVAL

1. Remove the digital display connector by pulling rearward with a slight sideways rocking motion.

2. Remove two screws from the transverse rails that are threaded into the top of the side panels and two screws similarly located on the bottom of the unit. (See Figure 5-2). Remove the rails.

3. If the rear panel has not been removed, the right side panel may be gently pushed out the amount necessary for the front panel to clear the groove. If the rear panel has been removed, pull the right side panel clear of the front panel.

CAUTION

Do not push the left side panel away from the front panel. Such action could damage the switch and LED that are attached to the controller circuit board.

4. Pivot the front panel clockwise around its left edge until it clears the LED and switch barrel. Then pull it clear of the groove in the left side panel.

5.4.3 CONTROLLER CIRCUIT BOARD REMOVAL

1. Remove the front panel as directed in 5.4.2. It is not necessary to remove the rear panel although that may be desirable so that free access to the back side of the circuit board may be achieved.

Table 5-2. Troubleshooting Guide.

SYMPTOM	POSSIBLE CAUSES
Temperature will not drop to set point that is below room temperature.	Defective STC. Defective cable or connector. Defective regulator circuit in DC Power Supply. Troubleshoot and repair. See symptoms below.
Temperature will not rise to set point that is above $-5^{o}C$.	Defective heater in STC. Defective cable or connector. Defective regulator circuit in DC Power Supply. Troubleshoot and repair. See symptoms below.
Temperature higher or lower than set point but is steadily maintained.	Unit requires calibration.
Temperature drifts over wide limits around set point.	Defective amplifier U6. Sensitivity (gain) of heater current regulator is set too high. Recalibrate and reset gain adjustment R7 to a lower value. No oil in bubbler thermowell.
During calibration, voltage at TP1 cannot be set at specified value.	Defective regulator U1 on regulator board. Defective op-amp U2-14. Leaky or shorted capacitor C1. Defective resistor in divider of R1, R8, and R9. Shorted capacitor C2.
During calibration, voltage at TP7 cannot be set at specified value.	Open diode CR8. Defective resistor in divider of R5, R17, and R18. Defective op-amp U3-1. Open resistor R32.
During calibration, voltage at TP2 cannot be adjusted with R2 to specified value.	Defective op-amp U2-1. Defective resistor in divider of R2, R10 and R11. Defective op-amp U2-8. Defective resistor in dummy probe.
During calibration, voltage at TP9 cannot be adjusted with R6 to specified value.	Defective resistor in divider of R6, R20 and R21. Defective op-amp U3-7.
Unit has been calibrated, but temperature is not regulated.	Defective component in circuit of op-amp U6-6. Defective component in circuit of timer U5. Defective solid state relay U9.

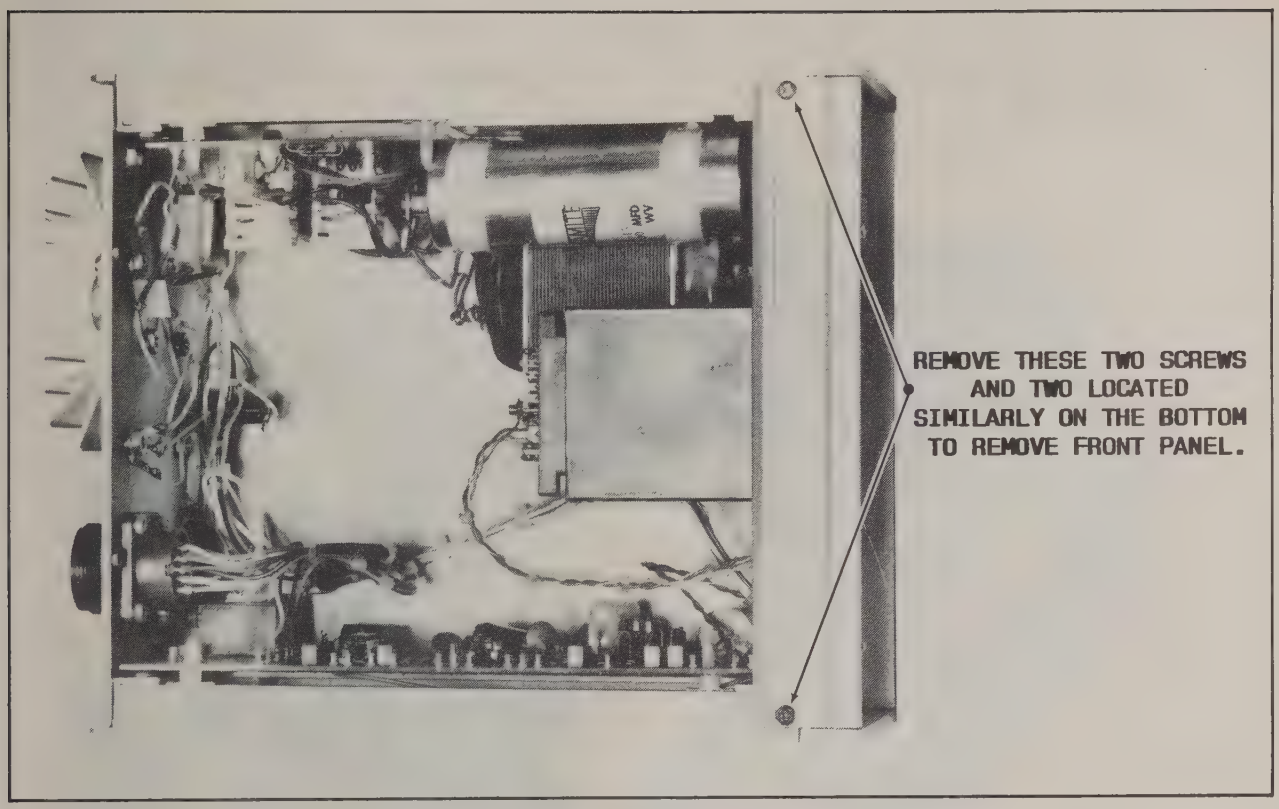


Figure 5-2. Front Panel Removal.

2. The circuit board is secured to the side panel by four plastic posts which have tangs that expand beyond the circumference of the holes to engage the surface of the circuit board. (See Figure 5-4). These tangs must be retracted by pressing them into the body of the post so that the circuit board may be removed. It is only necessary to grasp the post on the top and bottom surfaces, where the tangs are present, between thumb and forefinger while pushing lightly outward on the circuit board. Release the two front posts then the two rear posts.

CAUTION

Do not pull the circuit board away from the post more than necessary to hold the tangs in retraction until the tangs of all four posts are retracted.

3. If the front and rear panels have been removed, the side panel may then be set aside, exposing the rear of the circuit board. Otherwise, the board may be pulled away from side panel to gain access to its backside.

5.4.4 REAR PANEL REMOVAL

1. Disconnect the three resistors that are connected between the transistor sockets on the rear panel and the power supply board by unsoldering at the transistor sockets. (See Figure 5-3). Make note of the connections so they may be properly reconnected at time of reassembly.

2. At the fuseholder for F2, disconnect the wire that runs to the power supply board. (See Figure 5-3).

3. Remove the four screws, two on the right and two on the left, that pass

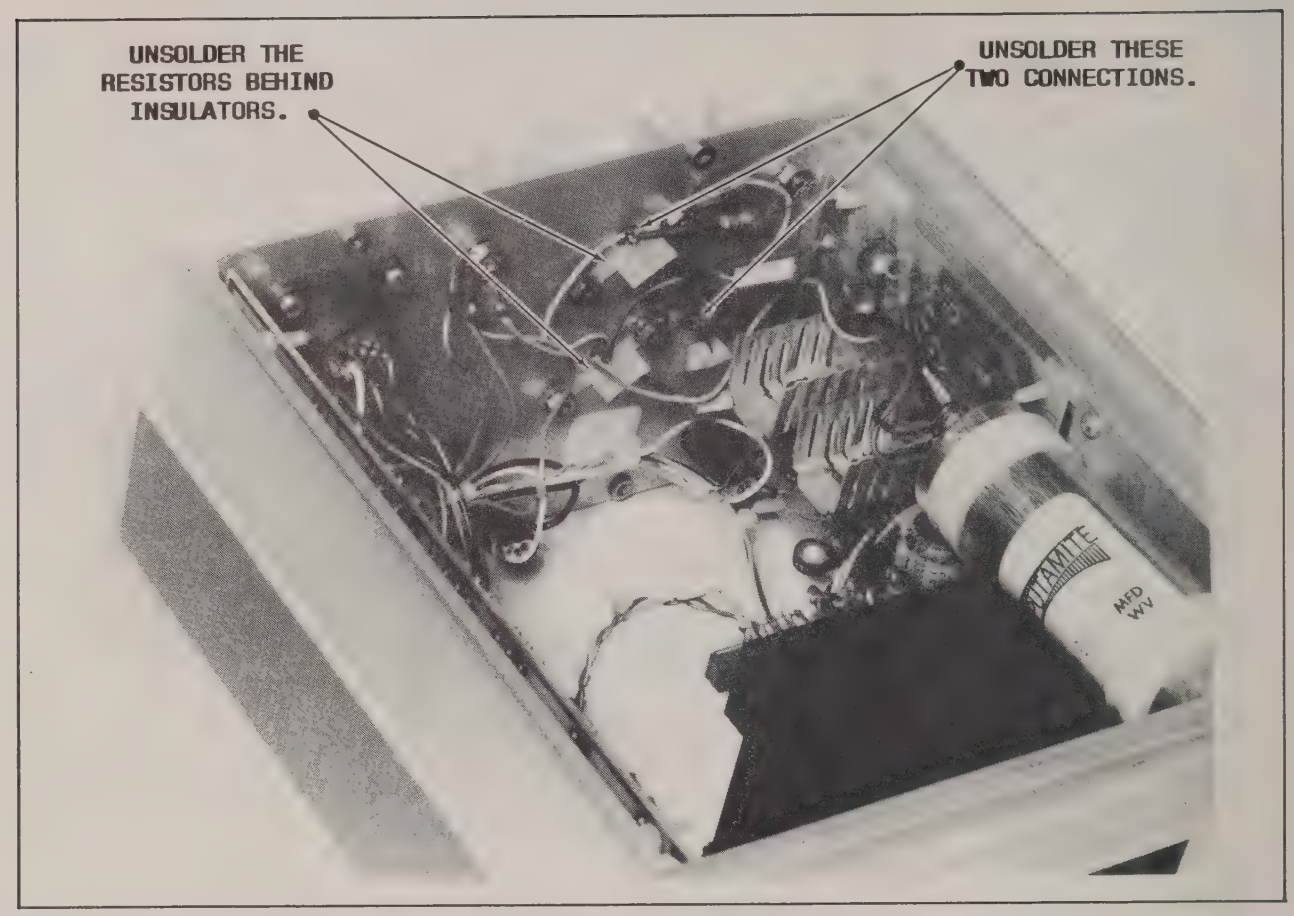


Figure 5-3. Rear Panel Connection Removal.

through the rear panel. The panel will remain attached to the rest of the unit by the wiring harness, but can be pulled clear for removal of the circuit boards.

5.4.5 POWER SUPPLY CIRCUIT BOARD REMOVAL

There are two methods of circuit board removal. The first leaves the board connected to the rear panel transistors so that it may be operated for troubleshooting purposes. This procedure is described in 5.4.5.1. The second requires disconnecting of the rear panel components and is described in 5.4.5.2.

5.4.5.1 Method 1

1. Remove the two screws on the right side of the rear panel.

2. Remove the screw that attaches the front top rail to the right side panel. Also, remove the screw that attaches the front bottom rail to the right side panel.

3. The circuit board is secured to the side panel by four plastic posts which have tangs that expand beyond the circumference of the holes to engage the surface of the circuit board. (See Figure 5-4). These tangs must be retracted by pressing them into the body of the post so that the circuit board may be removed. It is only necessary to grasp the post on the top and bottom surfaces, where the tangs are present, between thumb and forefinger while pushing lightly outward on the circuit board. Release the two front posts then the two rear posts.

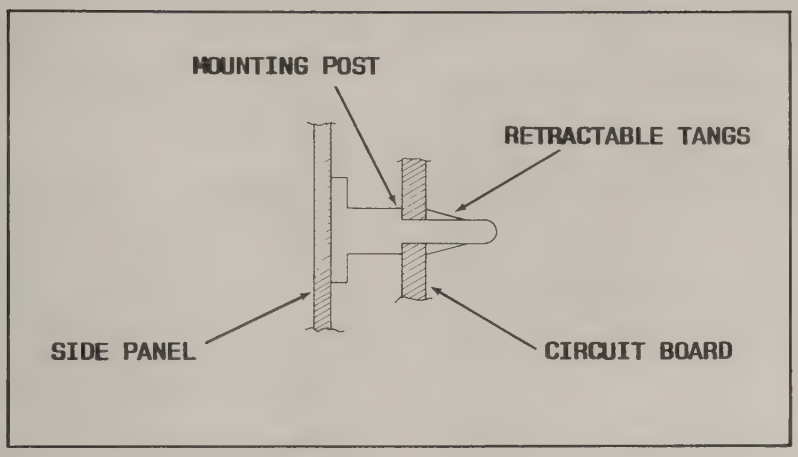


Figure 5-4. Cross Section of Circuit Board Mounting Post.

CAUTION

Do not pull the circuit board away from the post more than necessary to hold the tangs in retraction until the tangs of all four posts are retracted. Also, use care that excess strain is not applied to the components that connect the power supply board and rear panel components.

4. Remove the two screws that attach the capacitor to the right side panel. The side panel may now be pulled away, leaving the circuit board connected to the rear panel.

5.4.5.2 Method 2

1. Remove the rear panel as directed in 5.4.4.

2. Push the large capacitor forward so that its body is clear of the circuit board. If the clamps are too tight, it will be necessary to loosen or remove the two screws that attach the clamps to the side panel.

3. The circuit board is secured to the side panel by four plastic posts which have tangs that expand beyond the circumference of the holes to engage the surface of the circuit board. (See Figure 5-4). These tangs must be retracted by pressing them into the body of the post so that the circuit board may be removed. It is only necessary to grasp the post on the top and bottom surfaces, where the tangs are present, between thumb and forefinger while pushing lightly outward on the circuit board. Release the two front posts then the two rear posts.

CAUTION

Do not pull the circuit board away from the post more than necessary to hold the tangs in retraction until the tangs of all four posts are retracted. Also, use care that excess strain is not applied to the components that connect the power supply board to rear panel components.

5.4.6 TRANSFORMER REMOVAL

1. Remove the front panel as directed in 5.4.2.

2. If the transformer is to be replaced, disconnect and mark all leads soldered to the transformer.

3. Remove the four screws through the transformer mounting brackets and withdraw the transformer through the bottom of the unit.

5.4.7 DIGITAL READOUT REMOVAL

It is possible to remove and replace the readout as described in the following numbered steps. However, the entire procedure is much easier if the front panel is removed as described in 5.4.2. Alternately, the contents of the unit may be removed by first removing the connector then firmly pressing on both sides of the display inside the escutcheon until it 'pops' out of the rear.

1. Remove the connector from rear of digital readout assembly.

2. Loosen the two screws, one on each side of the readout assembly. Unthread them until they are flush with the front side of the clips that are inserted in the side of the readout.

3. Using the screws as handles, fold the clips forward so they lay flat against the side of the readout. They can then be removed by pulling the screws away from the side of the assembly.

4. Push the readout assembly through the front panel.

5.4.8 PUSH BUTTON REMOVAL

The lamps in the push button switches are neon units that should last the useful life of the unit and are, therefore, not replaceable. If a lamp fails, the entire switch must be replaced. Since there should be no occasion to remove a switch unless it is defective, the following procedure destroys the switch body to ease removal.

1. Remove the front panel as directed in 5.4.2.

2. Disconnect the wires soldered to the switch. Make note of terminals to which each wire is connected so they may be properly reconnected to the new switch.

3. The switches are snap-in devices with serrated tangs which makes removal by depression of the tangs difficult. It is simpler to insert a screwdriver blade between the tang and the switch body and rotate the screwdriver to break the tang. The switch can then be pushed forward out of the front panel.

4. The replacement switch should be properly oriented before insertion. Be sure that the numeral 1 on the rear surface of the switch is on top. Then push the switch firmly into the front panel opening.

5. If the replacement switch is not provided with an engraved cap, the cap on the defective switch may be removed by grasping between thumb and forefinger and pulling it off. It can then be placed on the new switch by merely pushing it into place.

SECTION VI—PARTS LISTS

6.1 GENERAL

This section of the manual contains lists of components that might require replacement during the service life of the Model 18 Power Supply. Parts lists for the Source Temperature Controllers are not included. The lists are arranged by assembly and include the circuit reference designator, where applicable, a description of the part and the J. C. Schumacher Co. part number. When commercial available components having the same characteristics as those listed are available, they may be used in substitution for the listed component.

When a component is of special design, it may be procured from J. C. Schumacher Co. Service Department. Some electrical items and structural items are in this category. When ordering, please provide equipment model and serial numbers, reference designator, if applicable, description and part number.

Table 6-1. Replaceable Parts List,
Controller Circuit Board.

Reference Designator	Description	Part No.
	CAPACITORS	
C1	4.7 mfd., Dipped Tantalum	1510-4762
C2	4.7 mfd., Dipped Tantalum	1510-4762
C3	0.1 mfd., 50V, Ceramic Disc	1500-1042
C4	0.1 mfd., 50V, Ceramic Disc	1500-1042
C6	0.1 mfd., 50V, Ceramic Disc	1500-1042
C7	22 mfd., 16V, 20% Tantalum	1510-2262
C13	22 mfd., 16V, 20% Tantalum	1510-2262
C14	220 mfd., 16, Electrolytic	1515-2280
C18	0.47 mfd., 100V, 10%, Mylar	1520-4742
C19	22 mfd., 16V, 20% Tantalum	1510-2262
C20	0.1 mfd., 50V, Ceramic Disc	1500-1042
C21	22 mfd., 16V, 20% Tantalum	1510-2262
C22	0.1 mfd., 50V, Ceramic Disc	1500-1042
C25	10 mfd., Polycarbonate	1525-1097
C27	22 mfd., Ceramic Monolithic	1501-2242
C29	5 mfd., 200VAC P lycarbonate	1525-0056
	DIODES	
CR1	1N4001	4801-4001
CR5	1N4001	4801-4001
CR7	Green LED	2451-190G
CR9	IN4001	4801-4001
	RESISTORS	
R1	500 Ohm, 10 Turn Potentiometer	4750-501P
R2	500 Ohm, 10 Turn Potentiometer	4750-501P
R5	500 Ohm, 10 Turn Potentiometer	4750-501P
R6	50K Ohm, 10 Turn Potentiometer	4750-503P
R7	50K Ohm, 10 Turn Potentiometer	4750-603P
R8	1.5 K Ohm, 1/4 Watt, 1% Metal Film	4721-1501
	*1.24 K Ohm, 1/4 Watt, 1% Metal Film	4721-1241
R9	475 Ohm, 1/4 Watt, 5%, Carbon Film	4721-4750
	*787 Ohm, 1/4 Watt, 5%, Carbon Film	4711-7870
R10	2.94K Ohm, 1/4 Watt, 1%, Carbon Film	4721-2941
	*4.64K Ohm, 1/4 Watt, 1%, Carbon Film	4721-4641
R11	2K Ohm, 1/4 Watt, 5%, Carbon Film	4721-2001
	*2.21K Ohm, 1/4 Watt, 1%, Carbon Film	4721-2211
R12	180K Ohm, 1/4 Watt, 5%, Carbon	4711-0184
R13	5.6K Ohm, 1/4 Watt, 5%, Carbon	4711-0562
R14	357K Ohm, 1/4 Watt, 5%, Carbon	4711-3573
R17	1.5K Ohm, 1/4 Watt, 1%, Metal Film	4721-1501
R18	1.8K Ohm, 1/4 Watt, 1%, Metal Film	4721-1801
R20	150K Ohm, 1/4 Watt, 1%, Metal Film	4721-1503
R21	150K Ohm, 1/4 Watt, 1%, Metal Film	4721-1503
R22	510 Ohm, 1/4 Watt, 5%, Carbon Film	4711-0511
R23	3.32K Ohm, 1/4 Watt, 1%, Metal Film	4721-3321
R24	12K Ohm, 1/4 Watt, 1%	4731-1202
R25	5.6K Ohm, 1/4 Watt, 5%, Carbon	4711-0562
R26	12K Ohm, 1/4 Watt, 1%	4731-1202
	*35.25K Ohm, 1/4 Watt, 1%	4731-3522
	**6.25K Ohm, 1/4 Watt, 1%	4731-6251
R27	5.7K Ohm, 1/4 Watt, 1%	4731-5701
	*18.7K Ohm, 1/4 Watt, 1%	4731-1872
	**3.20K Ohm, 1/4 Watt, 1%	4731-3201
R28	12K Ohm, 1/4 Watt, 1%	4731-1202
R29	357K Ohm, 1/4 Watt, 1%, Metal Film	4721-3573
R30	100K Ohm, 1/4 Watt, 1%,	4731-1003
R31	51K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0392
R32	100K Ohm, 1/4 Watt, 1%,	4731-1003
R33	357K Ohm, 1/4 Watt, 1%, Metal Film	4721-3573
R34	3.9K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0390
R35	3.32K Ohm, 1/4 Watt, 1%, Metal Film	4721-3321
R36	357K Ohm, 1/4 Watt, 1%, Metal Film	4721-3573
R37	357K Ohm, 1/4 Watt, 1%, Metal Film	4721-3573
R40	10K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0103
R44	270 Ohm, 1/4 Watt, 5%, Carbon Film	4711-2701
R60	15K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0153
R61	22K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0223
R62	100K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0104
R63	100K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0104

(Continued)

Reference Designator	Description	Part No.
	Table 6-1. (Continued)	
R64	1M Ohm, 1/4 Watt, 5%, Carbon Film	4711-0105
R65	22K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0223
R66	22M Ohm, 1/4 Watt, 5%, Carbon Film	4701-0226
R67	22M Ohm, 1/4 Watt, 5%, Carbon Film	4701-0226
	*Low temperature units only.	
	**High temperature units only.	
	INTEGRATED CIRCUITS	
U1	2.5 Volt Regulator, AD580J	3139-580J
U2	Operational Amplifier, LM324N	3130-324N
U3	Operational Amplifier, LM324N	3130-324N
U4	Operational Amplifier, LM324N	3130-324N
U5	Voltage Controlled Oscillator, 4151 N/E	3152-4151
U6	Solid State Relay	3133-3140
	SWITCH	
SW1	DPDT, ON-ON-ON, Toggle	5100-7215

Table 6-2. Replaceable Parts List, PSDIG-14 Power Supply Board.

Reference Designator	Description	Part No.
	CAPACITORS	
C2	3300 mfd., 16V, Electrolytic	1515-3382
C3	4.7 mfd., Dipped Tantalum	1510-4762
C4	4.7 mfd., Dipped Tantalum	1510-4762
C5	22 mfd., Dipped Tantalum	1510-2262
C6	4.7 mfd., Dipped Tantalum	1510-4762
C7	4.7 mfd., Dipped Tantalum	1510-4762
C8	0.1 mfd., Ceramic Disc	1500-1042
C9	100 pfd., Ceramic Disc	1500-1013
C10	4.7 mfd., Dipped Tantalum	1510-4762
	DIODES	
CR1	MR750	4802-R570
CR2	1N4001	4801-4001
CR3	MR750	4802-R570
CR4	1N4001	4801-4001
CR5	1N4001	4801-4001
CR6	1N4001	4801-4001
CR7	1N4001	4801-4001
CR8	1N4001	4801-4001
CR9	1N4001	4801-4001
	RESISTORS	
R1	220 Ohm, 1/4 Watt, 5%, Carbon Film	4711-0221
R2	0.3 Ohm, 10 Watt Wire Wound	4762-00R3
R3	0.3 Ohm, 10 Watt Wire Wound	4762-00R3
R4	100K Ohm, 1 Turn Carbon Pot	4753-104H
R5	150 Ohm, 1/4 Watt, 5%, Carbon Film	4711-0154
R6	100K Ohm, 1/4 Watt, 5%, Carbon Film	4711-0104
R7	220 Ohm, 1/4 Watt, 5%, Carbon Film	4711-0221
R8	1K Ohm, 1 Turn Carbon Pot	4753-102H
	INTEGRATED CIRCUITS	
U1	Voltage Regulator, LM337T	3139-337T
U2	Voltage Regulator, LM340T-5	3139-340T
U3	Operational Amplifier, LM741	3130-741P
U4	Negative Voltage Regulator, LM7905	3139-7905

Table 6-3. Replaceable Parts List, DC Power Supply Board. Model PSDIG-18 and Variants.

Reference Designator	Description	Part No.
	CAPACITORS	
C1	Not Used	
C2	4.7 mfd., 16V, Electrolytic	1516-4762
C3	4.7 mfd., 16V, Electrolytic	1516-4762
C4	3300 mfd., 16V, Electrolytic	1515-3382
C5	4.7 mfd., 16V, Electrolytic	1516-4762
C6	4.7 mfd., 16V, Electrolytic	1516-4762
C7	4.7 mfd., 16V, Electrolytic	1516-4762
C8	0.01 mfd., 50V, Ceramic Disc	1500-1032
C9	0.01 mfd., 50V, Ceramic Disc	1500-1032
	DIODES	
CR1	Rectifier, MR750, Motorola	4802-R750
CR2	Rectifier, 1N4001, IRC	4801-4001
CR3	Rectifier, MR750, Motorola	4802-R750
CR4	Rectifier, 1N4001, IRC	4801-4001
CR5	Rectifier, 1N4001, IRC	4801-4001
CR6	Rectifier, 1N4001, IRC	4801-4001
CR7	Rectifier, 1N4001, IRC	4801-4001
CR8	Rectifier, 1N4001, IRC	4801-4001
CR9	Switching Diode, 1N4148, Tex. Instr.	4800-4148
	TRANSISTORS	
Q1	PNP, MPS-U55, Motorola	4813-0055
	RESISTORS	
R2	0.1 Ohm, 5 Watt, Sandbar	4761-0001
R3	10 Ohms, 1/2 Watt, 5%	4712-0101
R4	10K Ohms, 1/4 Watt, 1%	4721-1002
R5	15K Ohms, 1/4 Watt, 1%	4721-1502
R6	33 Ohms, 5 Watt, Sandbar	4761-0033
R7	1K Ohms, 1/4 Watt, 5%	4711-0102
R8	100K Ohms, 1/4 Watt, 5%	4721-1003
R9	100K Ohms, 1/4 Watt, 5%	4721-1003
R10A	0.1 Ohm, 5 Watt, Sandbar	4761-0001
R10B	0.1 Ohm, 5 Watt, Sandbar	4761-0001
R11	10K Ohms, 1/4 Watt, 5%	4721-1002
R12	1K Ohms, 1/4 Watt, Trimpot	4753-102H
R13	270K Ohms, 1/4 Watt, 5%	4711-0274
R14	10K Ohms, 1/4 Watt, 1%	4721-1002
R15	470 Ohms, 1/4 Watt, 5%	4711-0471
	INTEGRATED CIRCUITS	
U1	LM324 Quad Op Amp	3130-324N
U2	MC7905CT 5V Regulator	3139-7905
U3	MC7806CT	3139-3406

Table 6-4. Replaceable Parts List, Chassis Assembly.

Reference Designator	Description	Part No.
C1	Capacitor	1517-2132
DRO	3-1/2 Digit Seven-Segment Display	1700-35AM
F1	Fuse, 3 Ampere	5109-3AG3
F2	Fuse, 8 Ampere	5109-3AG8
J1	Connector, 3102 A2011S	2100-002S
J3	Card Edge Connector (DRO)	2160-0020
Q1	Transistor, MS15001	4811-5001
SW1	Lighted Switch, POWER	5101-DLA1
SW2	Lighted Switch, COOL	5101-DLA2

(Continued)

Table 6-4. (Continued)

Reference Designator	Description	Part No.
T1	Transformer, Power (PSDIG-14)	5600-0204
T1	Transformer, Power (PSDIG-18)	5600-0200
	Fuse Holder, Body	2159-1653
	Fuse Holder, Carrier	2159-1666
	Transistor Mounting Socket	2800-4616
	Transistor Mounting Insulator	2500-3223
	Capacitor Mounting Clamps	2800-0034
	Line Cord	6000-008B
	Rubber Support Foot w/Hardware	2800-001
	Cable Assembly, Power Supply to STC Interconnect	2101-0001
	Temperature Probe Assembly	5340-0000
	Line Cord Receptacle	2150-8843

SECTION VII—DIAGRAMS

7.1 GENERAL

The diagrams of this sections are those necessary for maintaining the electronic circuits of the PSDIG Series Power Supplies. They include electrical schematic diagrams and circuit board diagrams showing locations of the electronic components.

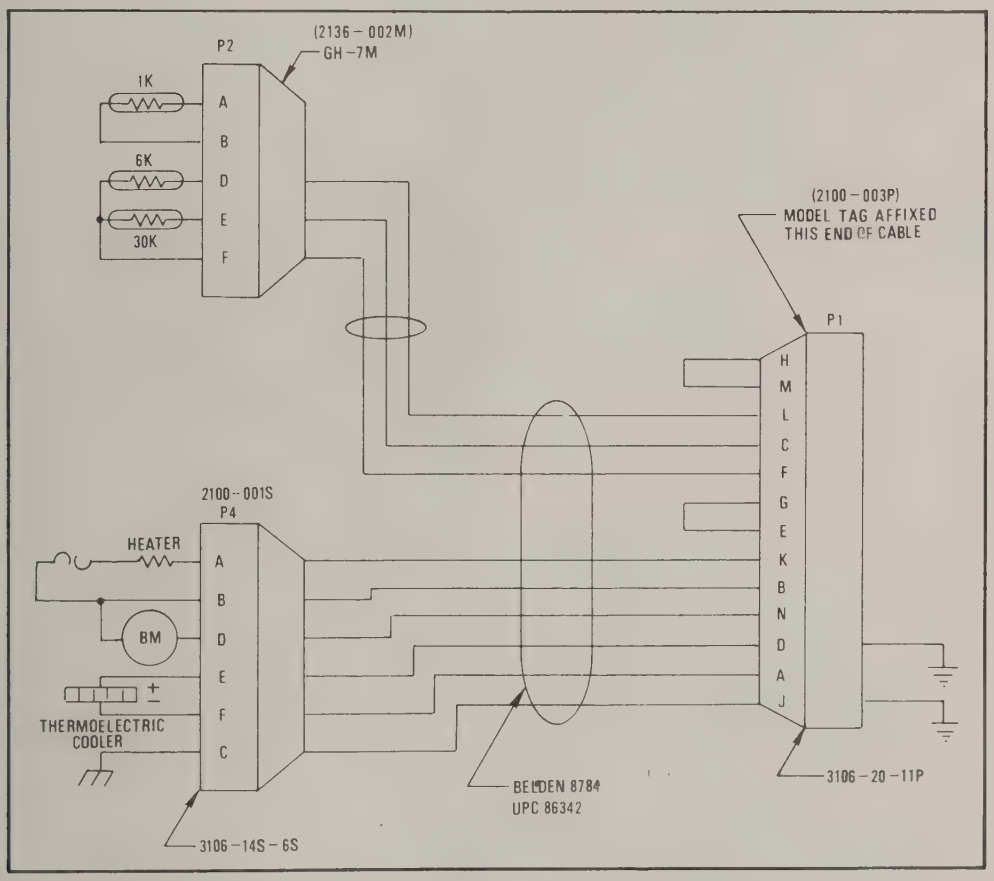


Figure 7-1. PSDIG/STC Interconnect Cable Diagram.

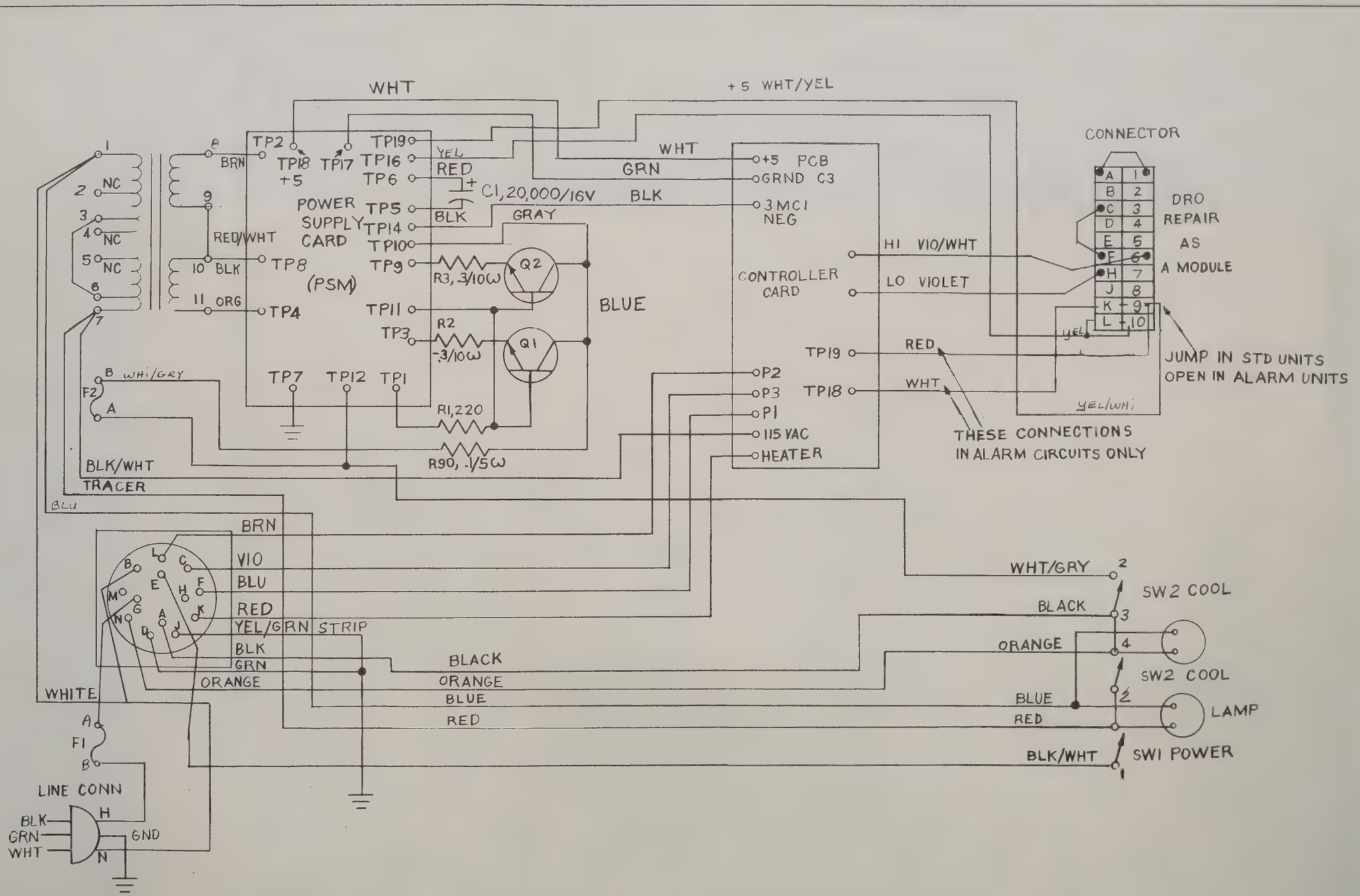
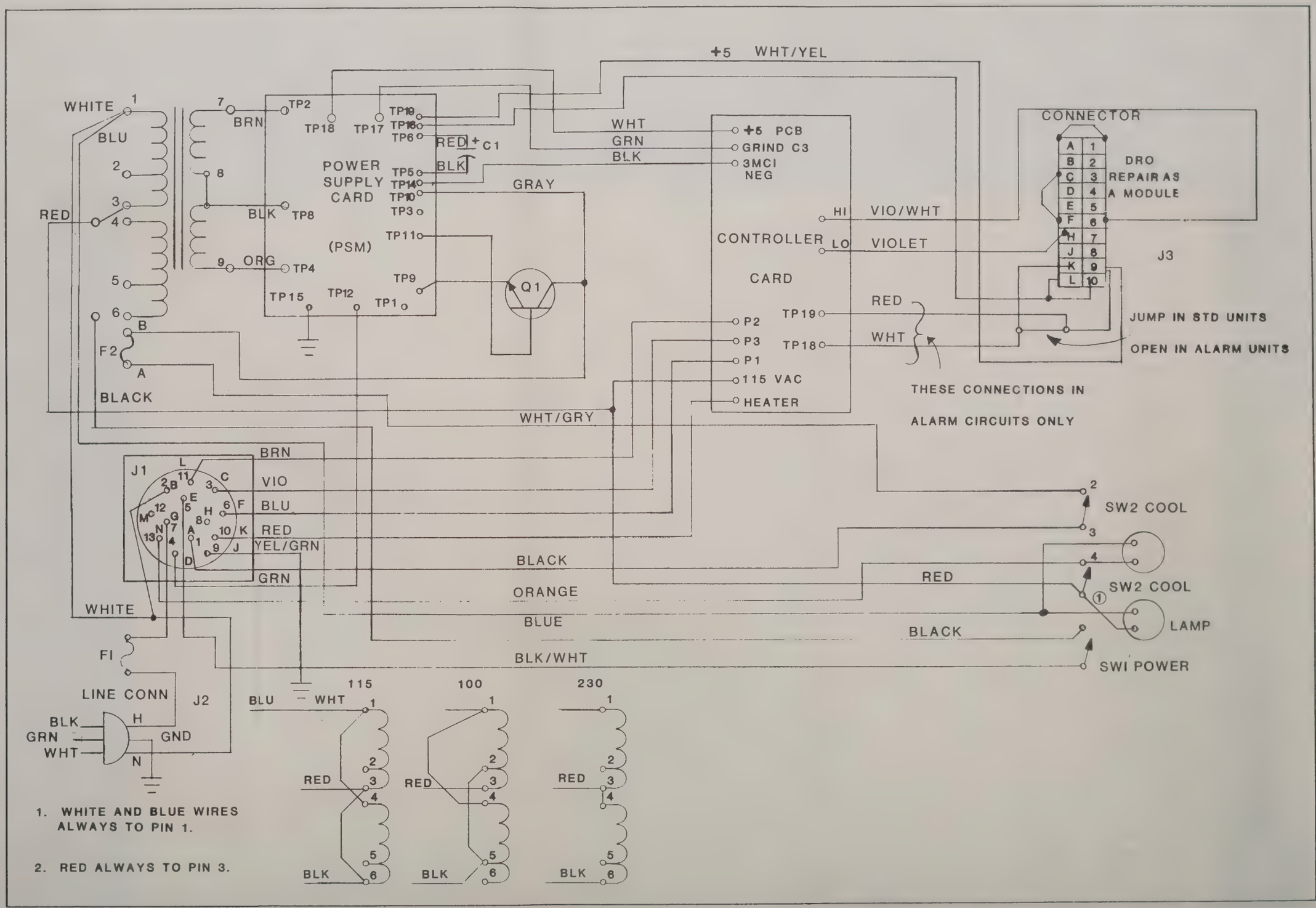


Figure 7-2. PSDIG-14 Series Power Supply Interconnect Diagram.



1. WHITE AND BLUE WIRES ALWAYS TO PIN 1.

2. RED ALWAYS TO PIN 3.

Figure 7-3. PSDIG-18 Series Power Supply Interconnect Diagram.

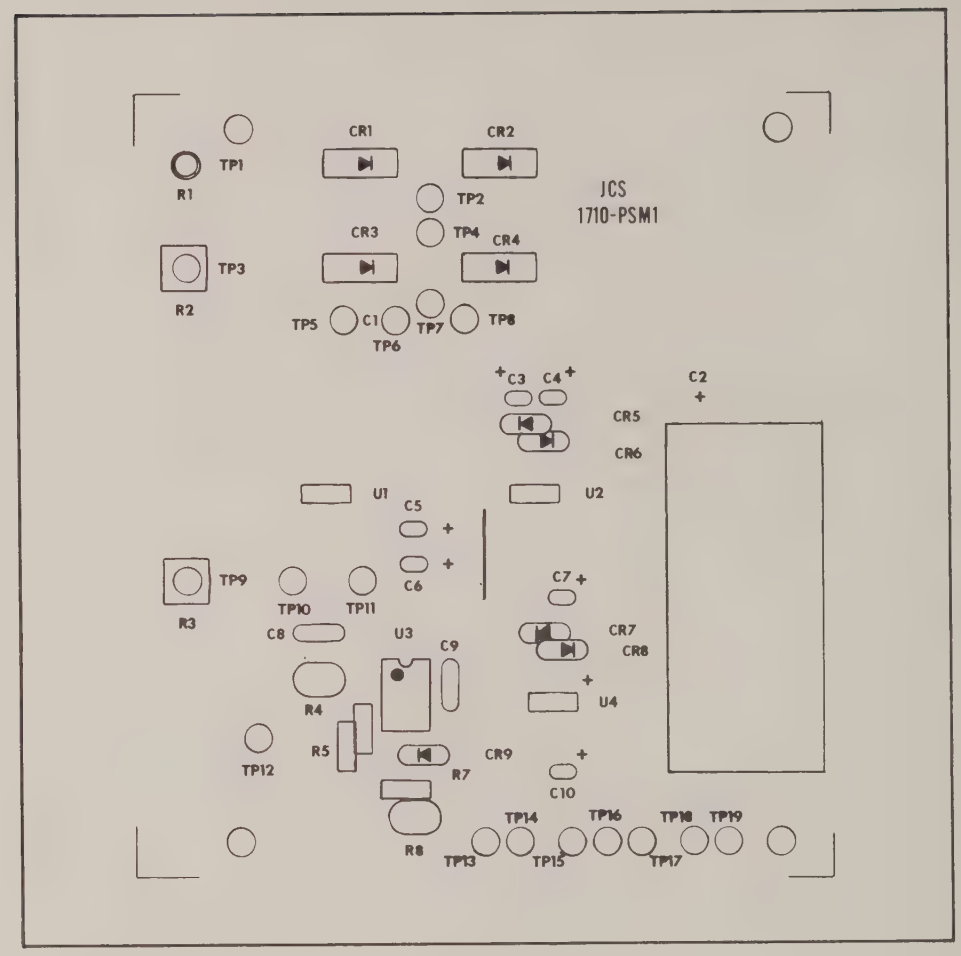


Figure 7-4. Component Locations,
PSDIG-14 Power Supply Circuit Board.

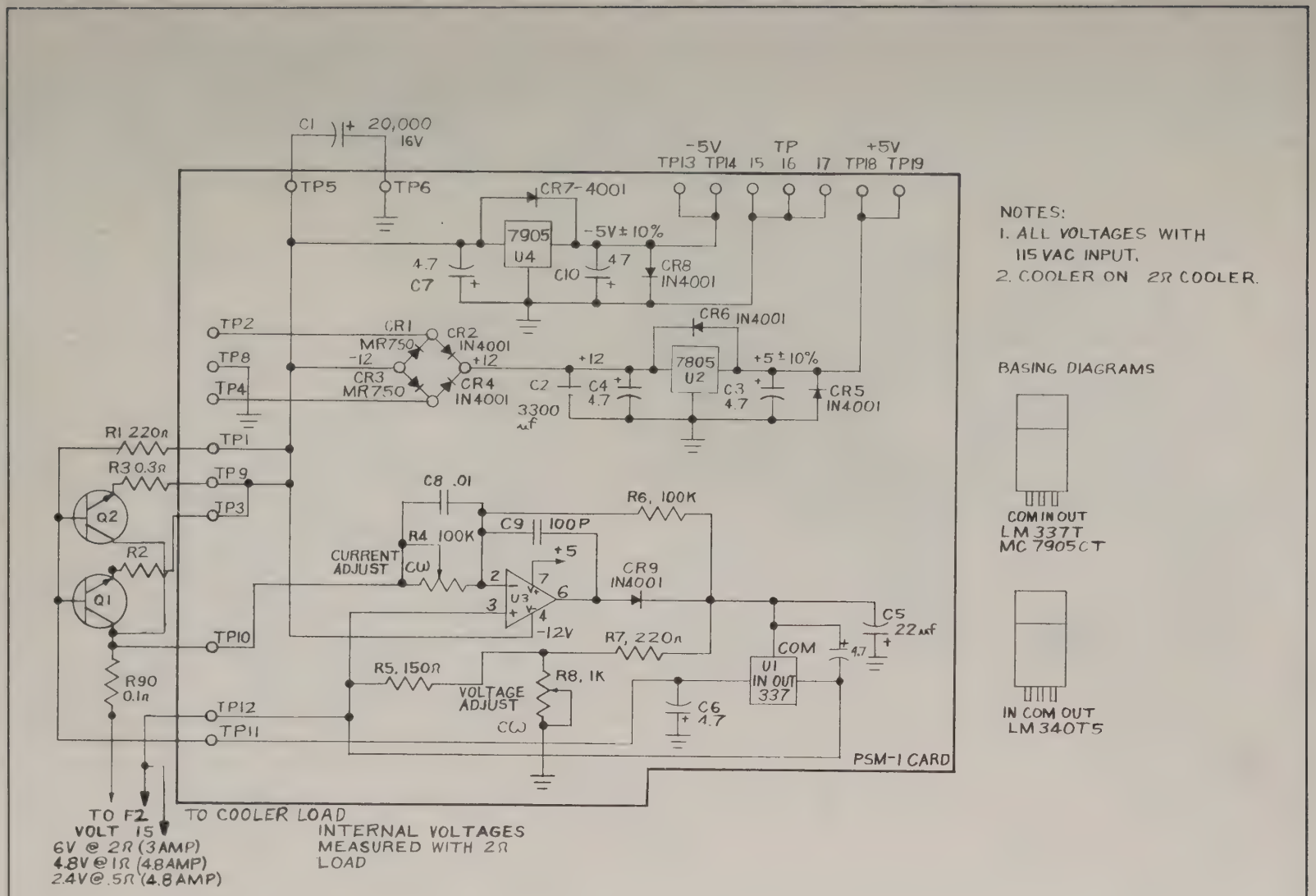


Figure 7-5. Schematic Diagram, PSDIG-14 Power Supply.

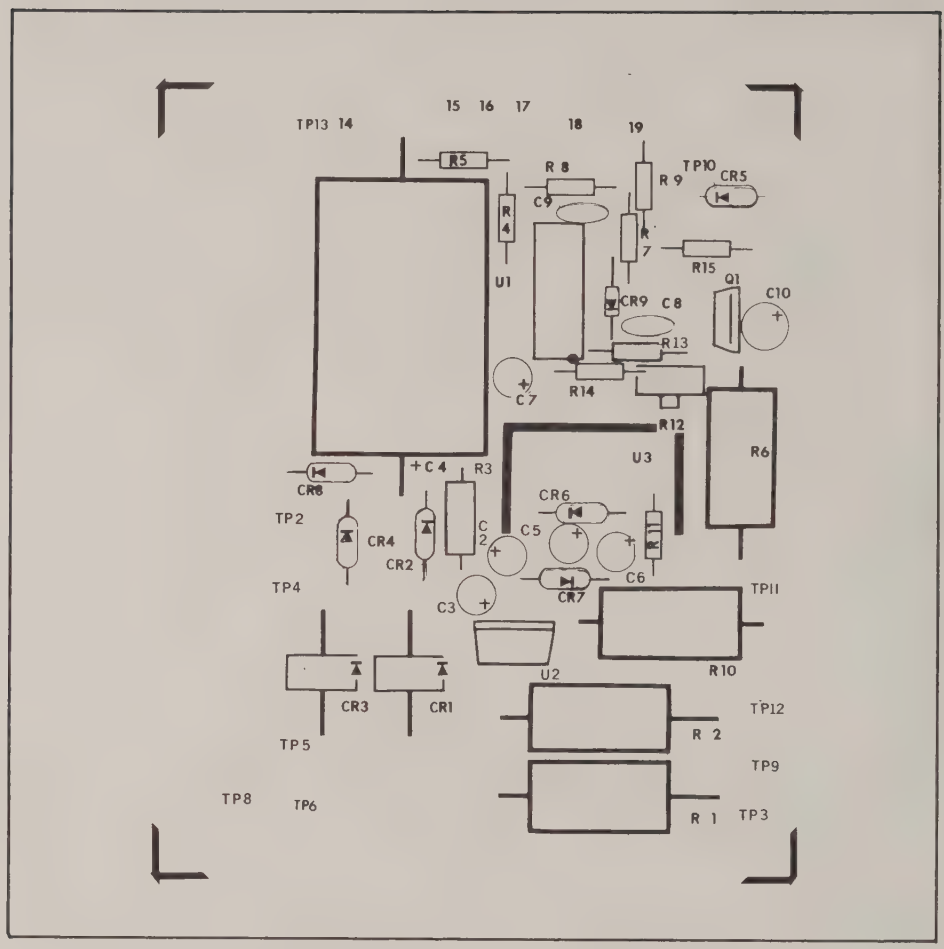


Figure 7-6. Component Locations,
PSDIG-18 Power Supply Circuit Board.

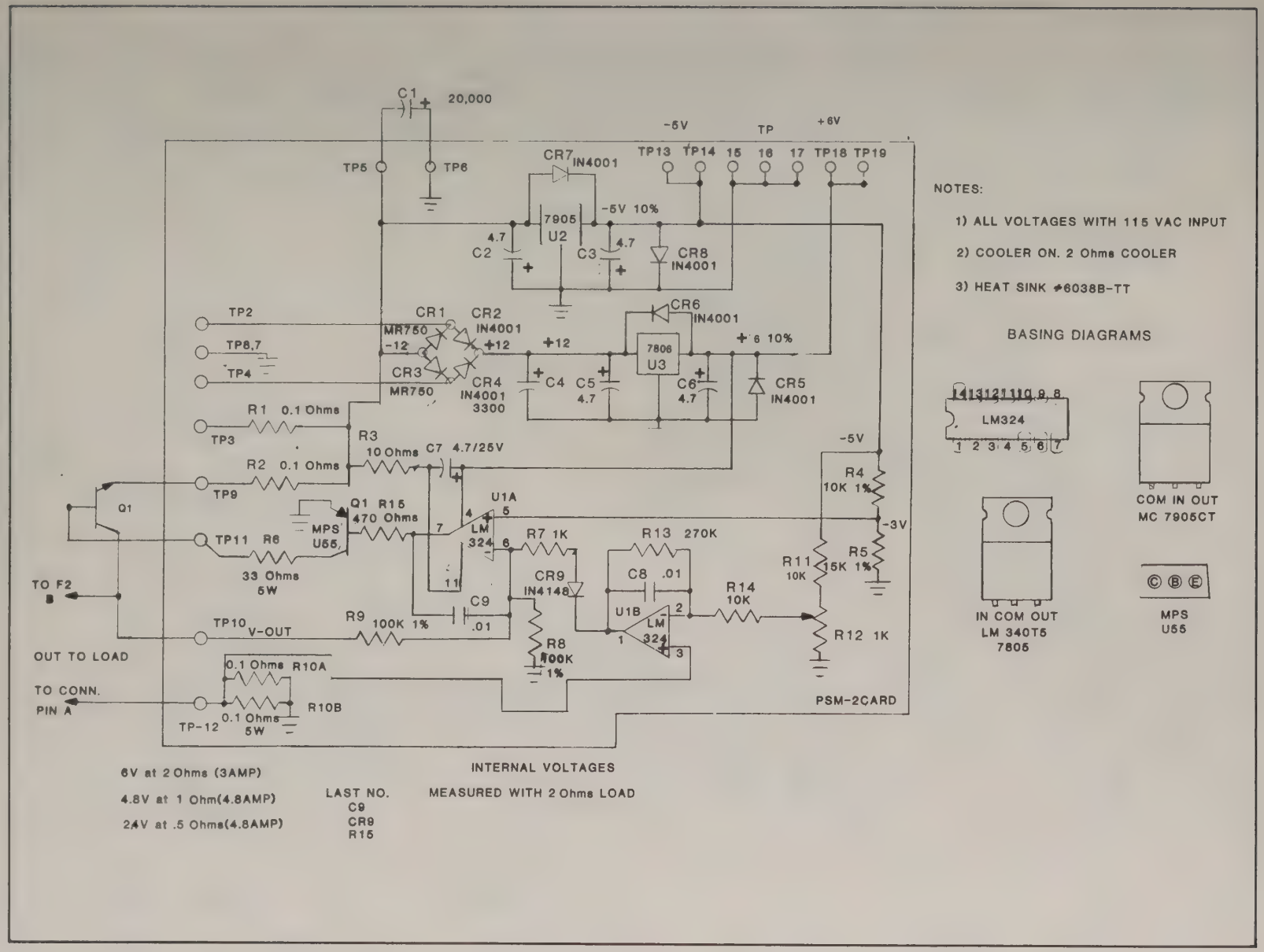


Figure 7-7. Schematic Diagram, PSDIG-18 Power Supply.

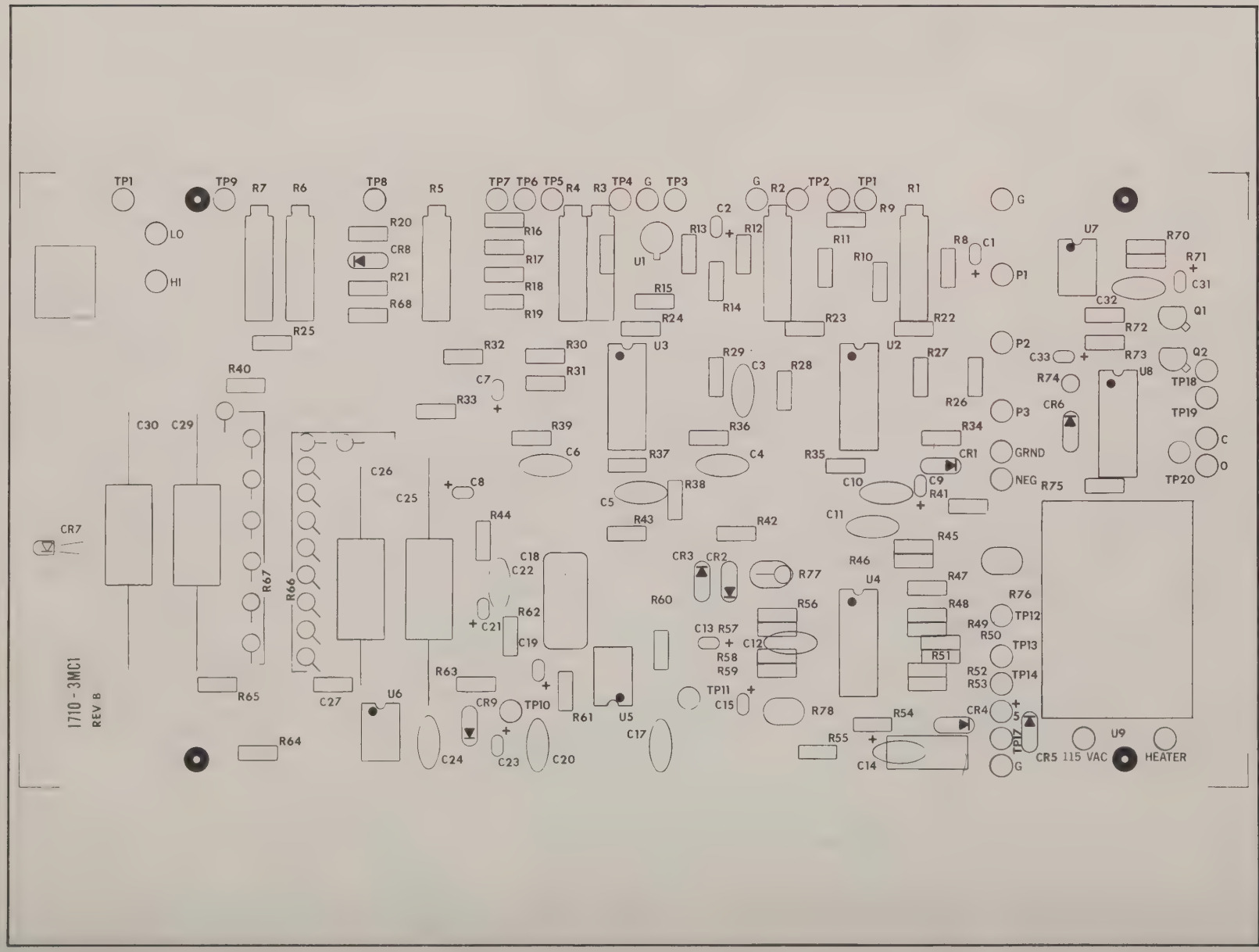


Figure 7-8. Component Locations, Temperature Controller Board.

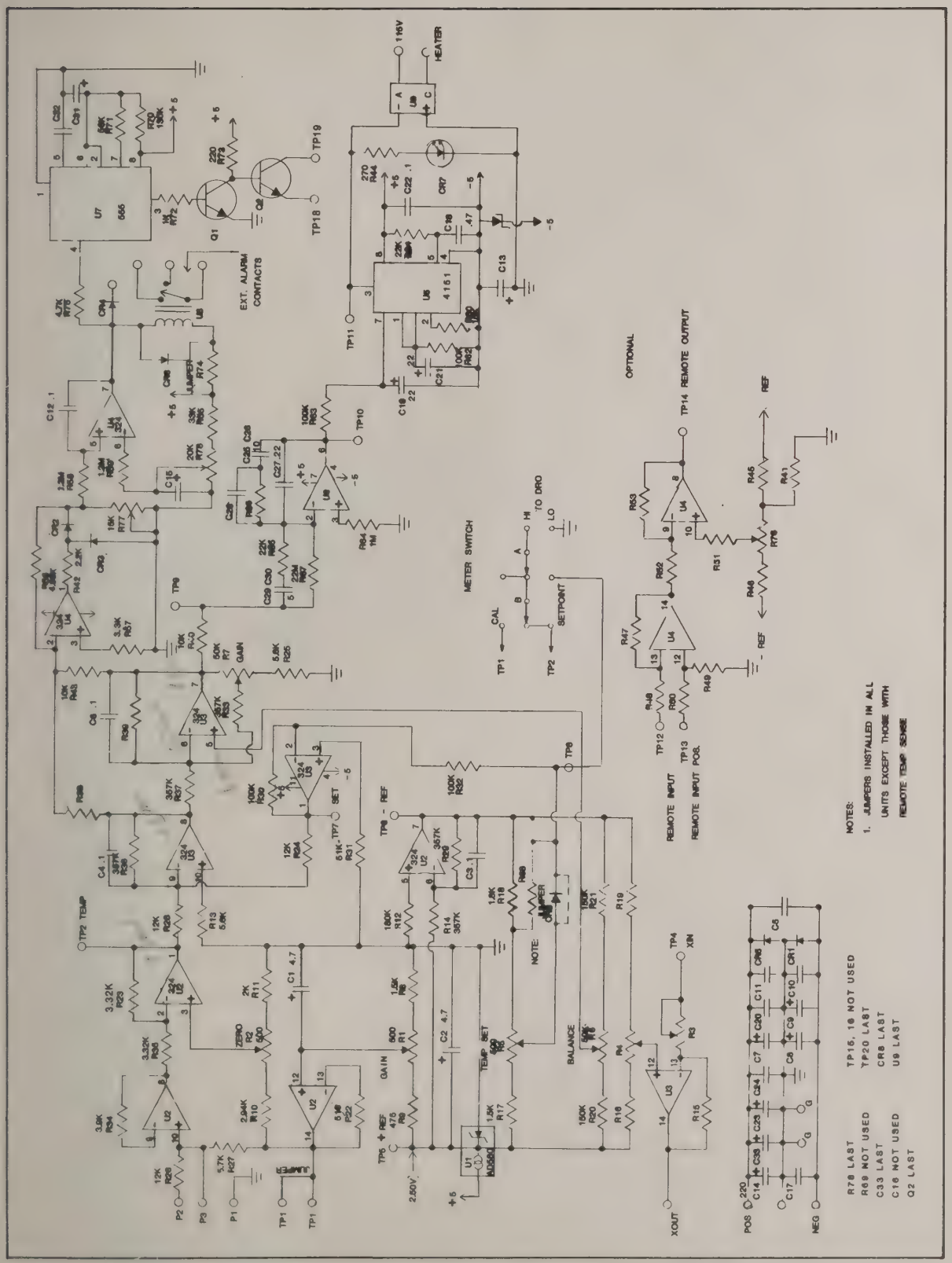


Figure 7-9. Schematic Diagram, Temperature Controller Board.

1710-3MC1
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